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FAST ION MASS SPECTROMETRY AND CHARGED PARTICLE SPECTROGRAPHY INVESTIGATIONS OF TRANSVERSE ION ACCELERATION AND BEAM-PLASMA INTERACTIONS

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1. SCIENCE OBJECTIVES

The principle scientific objective of this project is an investigation of ion acceleration transverse to the magnetic field in the topside ionosphere. Transverse acceleration is believed to be responsible for the upward-moving conical ion distributions (or "conics") commonly observed along auroral field lines at altitudes from several hundred to several thousand kilometers. Since these conics are observed in conjunction with ion cyclotron wave activity, the current theoretical understanding is that the ions are heated transverse to the magnetic field by VLF waves at harmonics of their gyrofrequencies, and then accelerated upward along the field by the magnetic mirror force. Such a mechanism is clearly important in the determination of the ultimate source of the magnetospheric plasma population (i.e. a terrestrial vs. a solar wind source).

Of primary concern in this investigation is the extent of these conic events in space and time. Theoretical predictions (e.g. Dusenbery and Lyons,1981) indicate very rapid initial heating rates, depending on the ion species. These same theories (in concurrence with observations) predict that the events will occur within a narrow vertical region of only a few hundred kilometers. Thus an instrument with very high spatial and temporal resolution was required for this investigation; further, since different heating rates were predicted for different ions, it was necessary to obtain composition as well as velocity space distributions.

The FIMS instrument was designed to meet these criteria. To facilitate rapid scans, measurements were limited to those energies (<2keV) and ions (O^+,NO^+,H^+,He^+) predicted to dominate the ion conic events (see Klumpar, 1979). High spatial resolution was further enhanced by the low speed and high telemetry rate of the sounding rocket (as compared with those of a satellite). The complete measurement objectives are given below:

Energy Range..1 eV/q to 2 keV/q
Ion Species..H^+, He^+, O^+, NO^+
Pitch-Angle Resolution..$\Delta\alpha = 1°$
Pitch-Angle Range for E/q Measurements.................. $\alpha = 0° - 180°$
Pitch-Angle Range for M/q Measurements..................$\alpha = 80° - 130°$
Time Resolution for complete (E/q,α) Distribution................. 1.1 s
Time Resolution for complete (E/q, M/q, α) Distribution.......... 6.6 s

2. INSTRUMENT DESCRIPTION

2.1 The Analyzers

Plate 1 is a photograph of the FIMS with an MCP detector mounted on the rocket deck plate.

The FIMS instrument consists of two pairs of spherical section conducting plates (R_{in}=28.9mm, ΔR_{in}=3.02mm; R_{out}=37.6mm, ΔR_{out}=3.88mm) acting as a dual-channel energy filter, followed by a cylindrical dual-channel (R_{in}= 73.7mm, ΔR_{in}=7.4mm; R_{out}=82.2mm, ΔR_{out}=8.2mm) ExB mass analyzer, and two channeltron detectors. Figure 2-1 is a schematic view of the instrument. The entrance housing provides a baffle for off-angle trajectories. The electrostatic plates are noryl coated with conducting paint and covered with lamp blacking to reduce scattering. The magnet is SmCo with a field strength of 1900 gauss. The ExB analyzer operates at a bias of -815V with respect to the electrostatic analyzer.

The flight detector consisted of two (2) Amperex B413-BL channeltrons with a grounded grid in front of them. The biasing network and amplifier circuit (supplied by Mullard Space Science Labs) used with them are shown in Figure 2-2.

The detector and pre-amp section of Figure 2-2 consists of two (2) Amptek, Inc., Model A111 Hybrid Charge Sensitive Pre-Amplifier/ Discriminator and Bias Networks packaged on a printed circuit board. A second circuit board houses an Amptek D400 Quad 8-bit Binary Counter and a 74HC244 Bus Driver.

An aluminum housing provides mounting for the two boards, as well as the two channeltrons. A 15-pin sub D connector provides the interface for the power and data lines.

2.2 Power Supplies

The programmable power supply (PPS) developed for the Fast Ion Mass Spectrometer is a new and totally different design from that used on previous programs, such as the Centaur I Sounding rocket. To provide a greater number of voltage steps and the versatility of programming for different instruments, two CMOS UV erasable PROMs were used as a lookup table addressed by the Central Electronics Package (CEP). The PROM output data provided input to a 10-bit D/A converter which performs as a staircase generator used to control the driver of the high-voltage transformer stage, as well as the control for the dynamic high-voltage shunt regulator.

Through a network of high-value resistors, a reference voltage is fed back to the control section to form a closed-loop system for better voltage regulation. Figure 2-3 is a block diagram of the PPS.

Isolation of the power supply secondary voltages is provided by transformer coupling in the input DC/DC converter, which provides the necessary digital and analog supply voltages. In the case of the mass PPS where the high-voltage return is at a float potential of as much as 3 kV, an additional P.C. card is provided which contains opto-isolators for the data and control lines, and a V/F - F/V circuit for the analog current monitors.

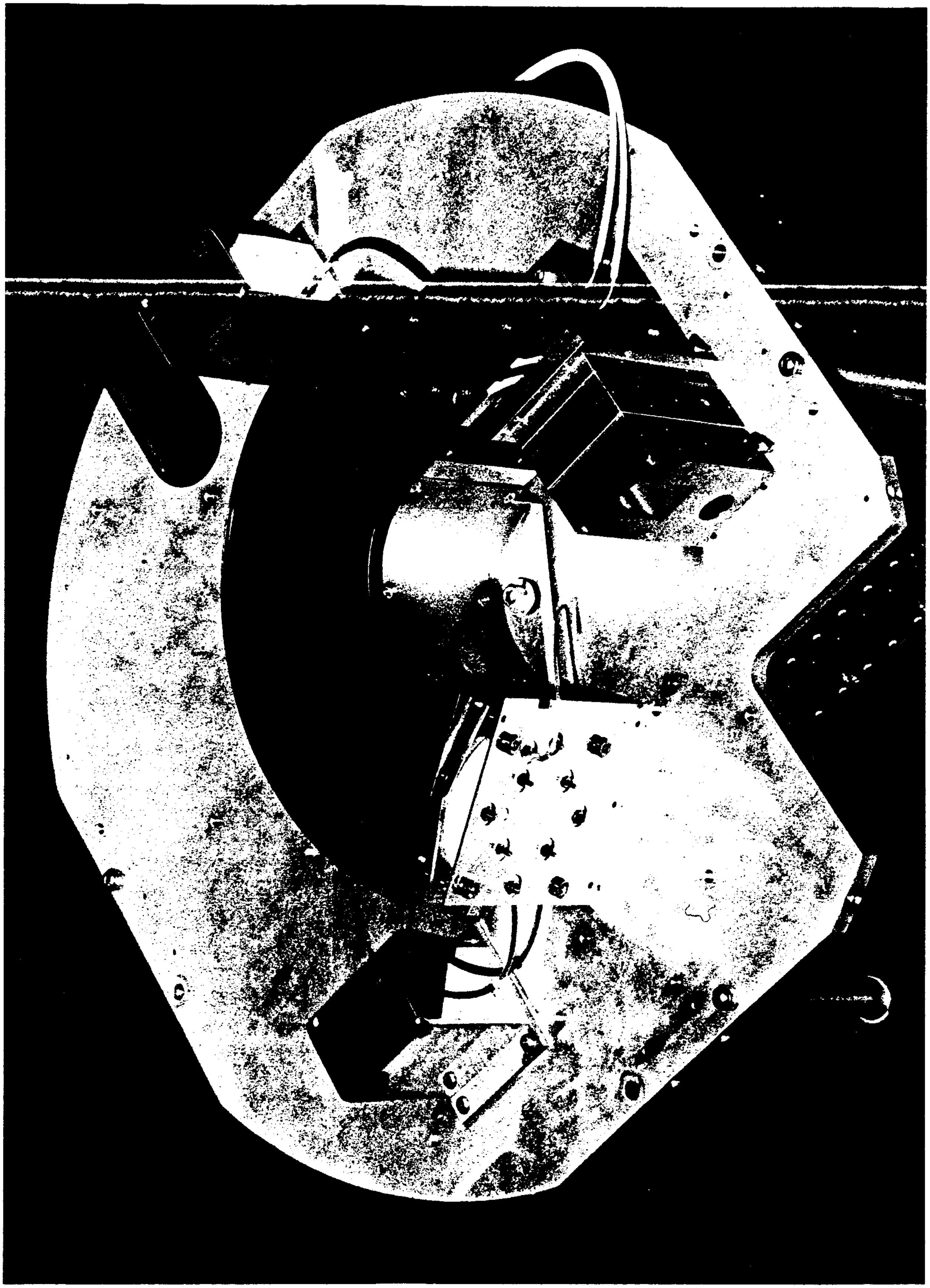

Plate 1. The FIMS Flight Unit in its Laboratory Configuration.

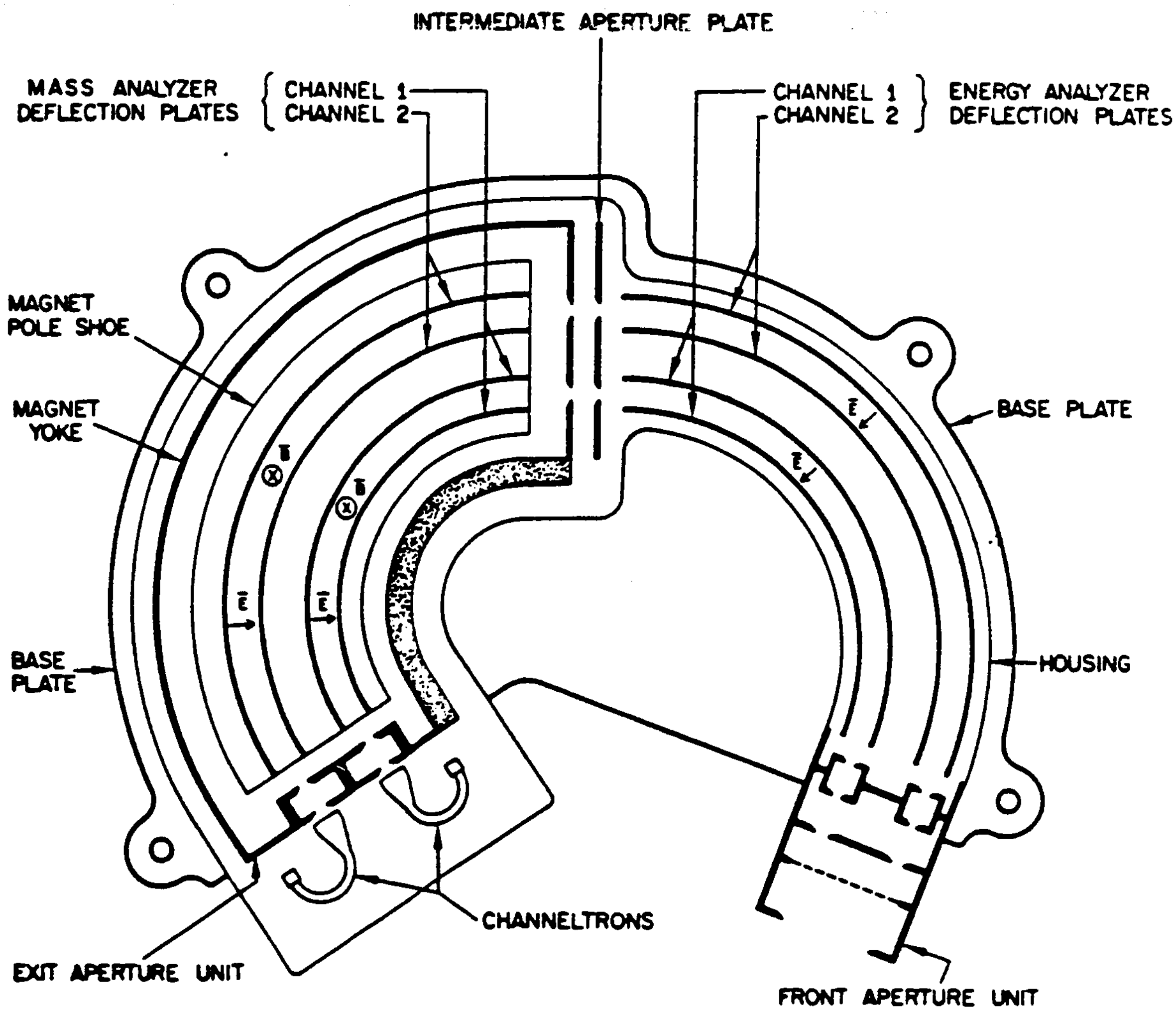

Figure 2-1 SCHEMATIC PRESENTATION OF THE DUAL-CHANNEL FAST ION MASS SPECTROMETER (FIMS).

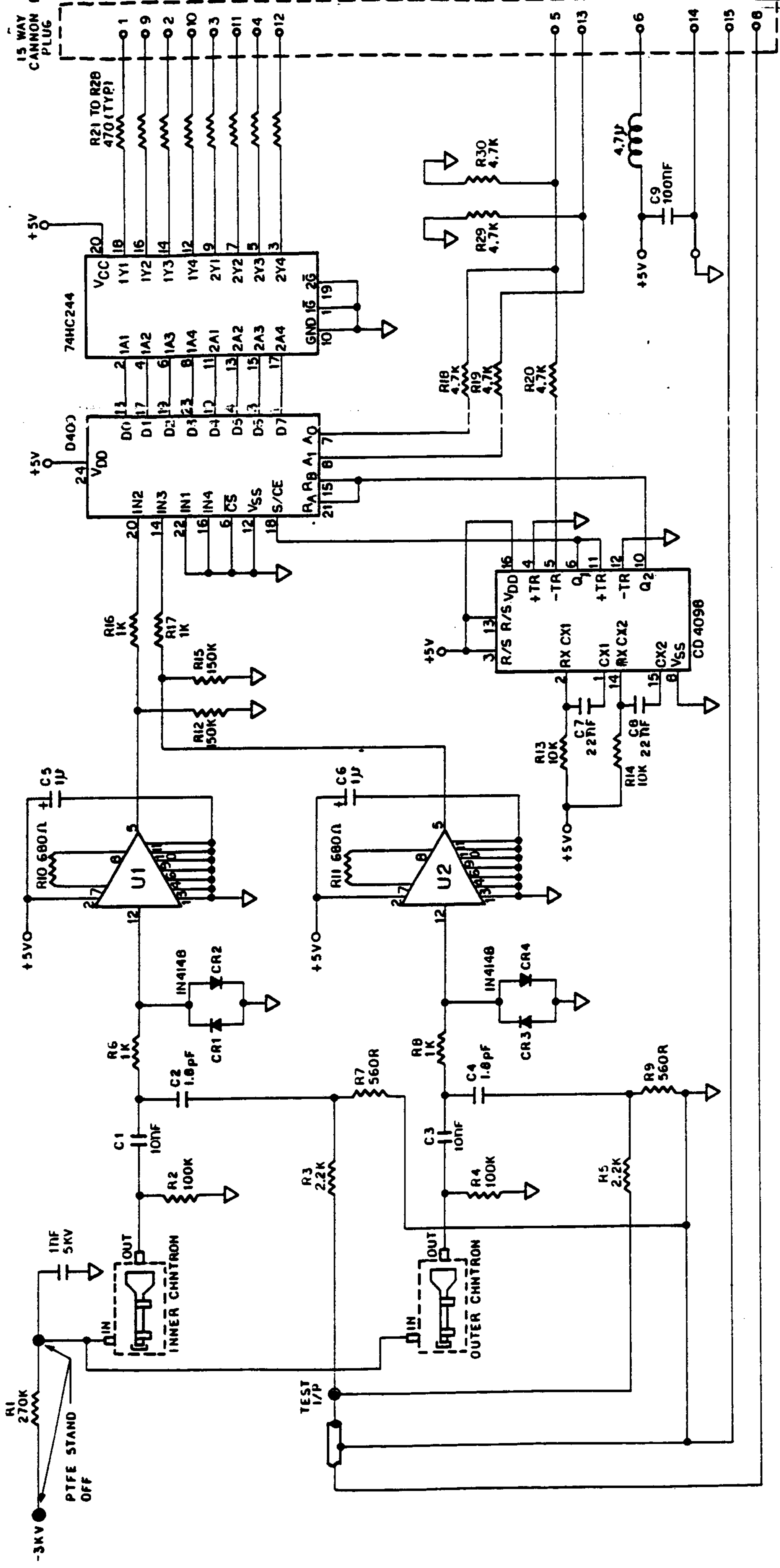

Figure 2-2 Schematic of Detector Amplifier Network

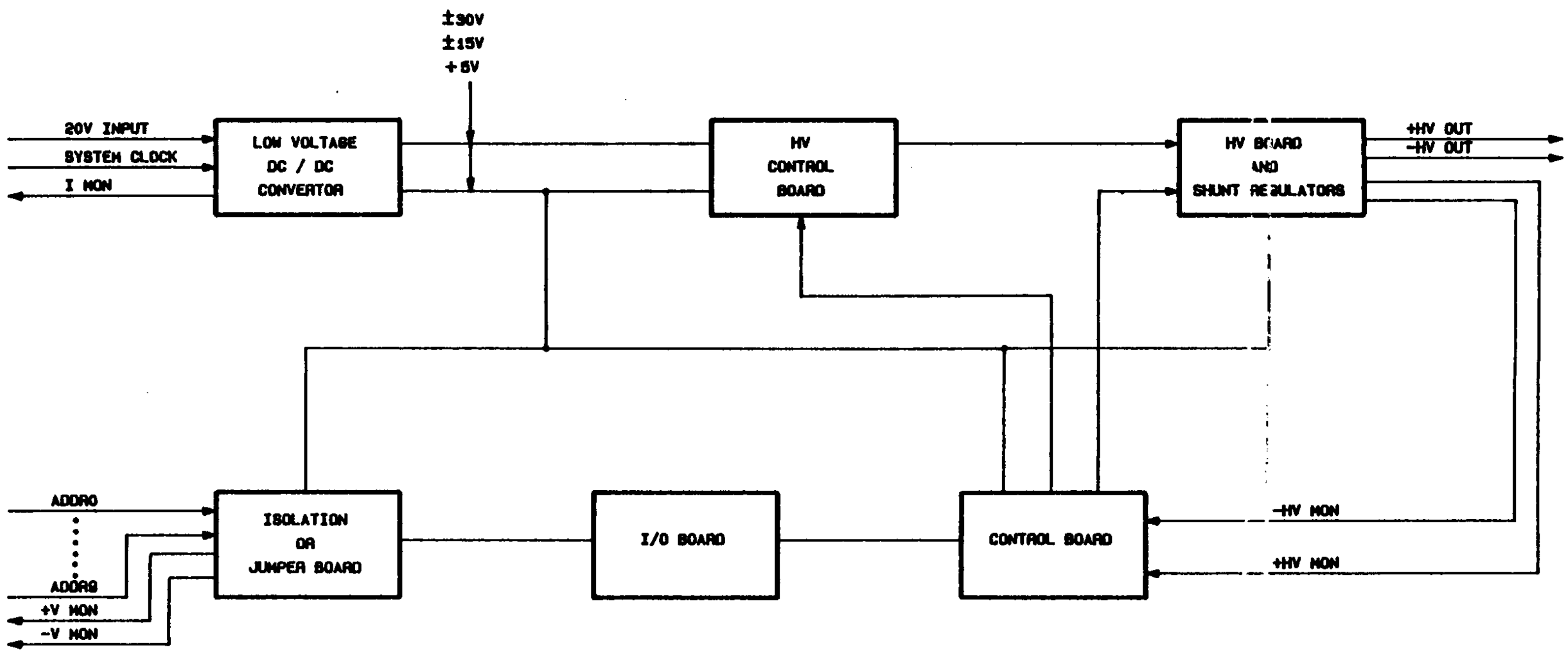

Figure 2-3 PPS Block Diagram

The fabrication of the power supply consisted of five separate epoxy glass P.C. boards and a single motherboard. The boards are divided into functional blocks to minimize circuit interconnects on the motherboard. For isolation, separate high-voltage connectors are used on the highvoltage sub-board to the motherboard where the high value resistor networks are located. The five boards are separated as follows: I/O board, Power Supply board, Control board, H.V. Control board, and H.V. board. In the isolated supply for the mass analyzer, an additional Isolation board is installed. A jumper board is installed for non-isolated operation. Figure 2-4 shows the component layout for the motherboard, and Figures 2-5 through 2-10 show the component layout for the six sub-boards.

The power supply is packaged in an aluminum housing, measuring 7 in. long x 4 in. wide x 2.5 in. deep. A 25-pin sub D connector provides the interconnections for the low-voltage control and supply. The high-voltage leads are routed through an epoxy glass insulator board and connected directly to the motherboard, eliminating exposed high-voltage terminals.

2.3 Central Electronics Package

The FIMS analyzer is controlled and monitored by a Central Electronics Package (CEP) shown in block diagram as Figure 2.3-1. The CEP is responsible for the generation of all Program Power Supply (PPS) commands as well as the acquisition of science data from the analyzer's detector assembly. Data acquired from the analyzer is formatted and relayed to the rocket's pulse code modulation (p.c.m.) telemetry subsystem at the appropriate time.

A 16 bit microprocessor with associated clock, memory and input/output circuitry is employed within the CEP. Circuitry for the CEP is contained on 4 plug-in printed wiring/stitchweld circuit boards all of which are housed in the single CEP enclosure. A detailed description of each of the 4 boards is contained in paragraphs to follow.

2.3.1 Central Processing Unit

Figures 2.3-2 through 2.3-6 are schematic diagrams of the FIMS CEP central processing unit (CPU). As can be seen in Figure 2.3-2, the CPU is controlled by an 80C86 microprocessor operating in the "minimum" configuration (without co-processors). The 80C86's clock and bus controller circuits can also be seen in Figure 2.3-2.

Since the 80C86 employees a multiplexed address/data bus it is necessary to de-multiplex the bus before it can be used to communicate with memory and I/O devices. Figures 2.3-3 and 2.3-4 show the manner in which the CPU bus is de-multiplexed within the FIMS CEP. The components used by the CEP are all complementary metal oxide semiconductor (CMOS) except for interface drivers.

In order to minimize the amount of circuitry needed by each of the 4 circuit boards for address decoding, a centralized I/O device decoding system, shown in Figure 2.3-6, is used by the CEP.To detect an I/O address , the system's 11 most significant address bits are compared to a preset values by 54HC688 octal comparators. When a true comparison is found, the system's

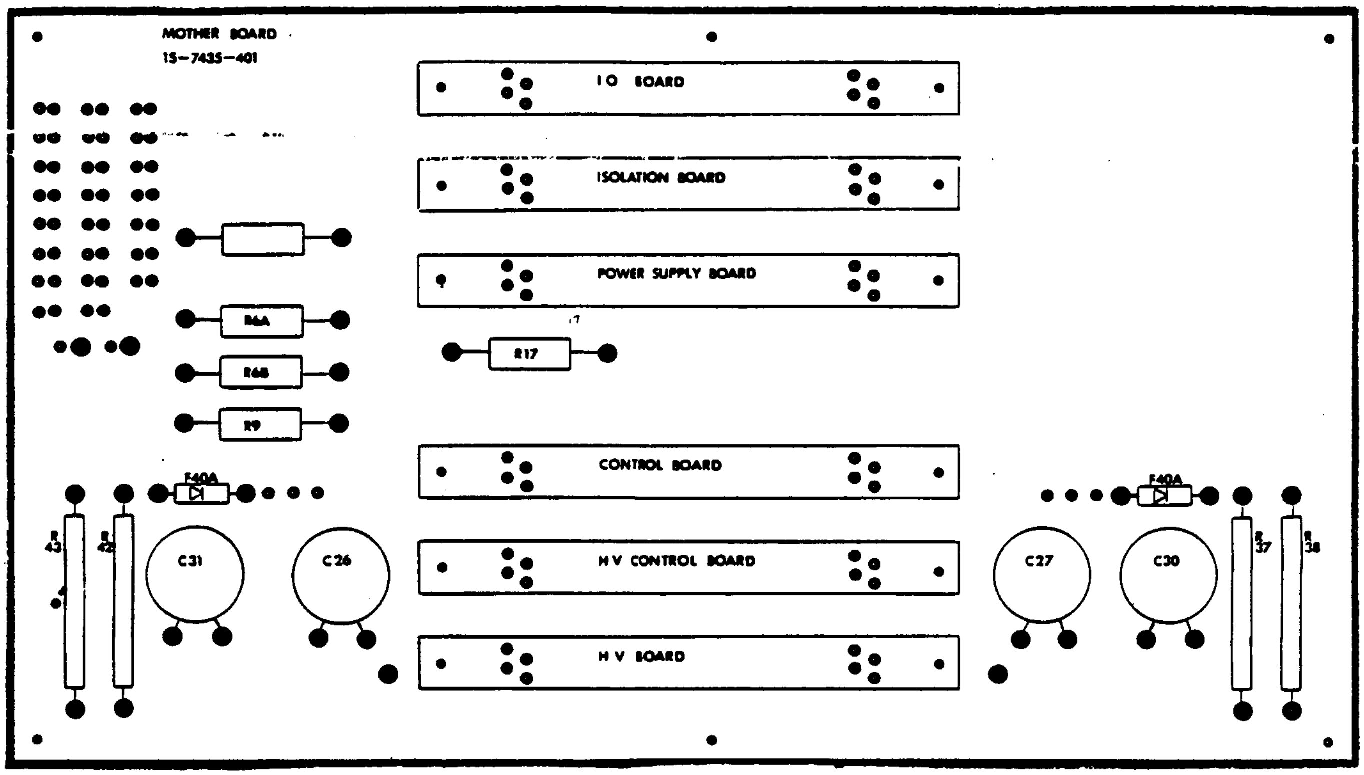

Figure 2-4 Component Layout of Motherboard

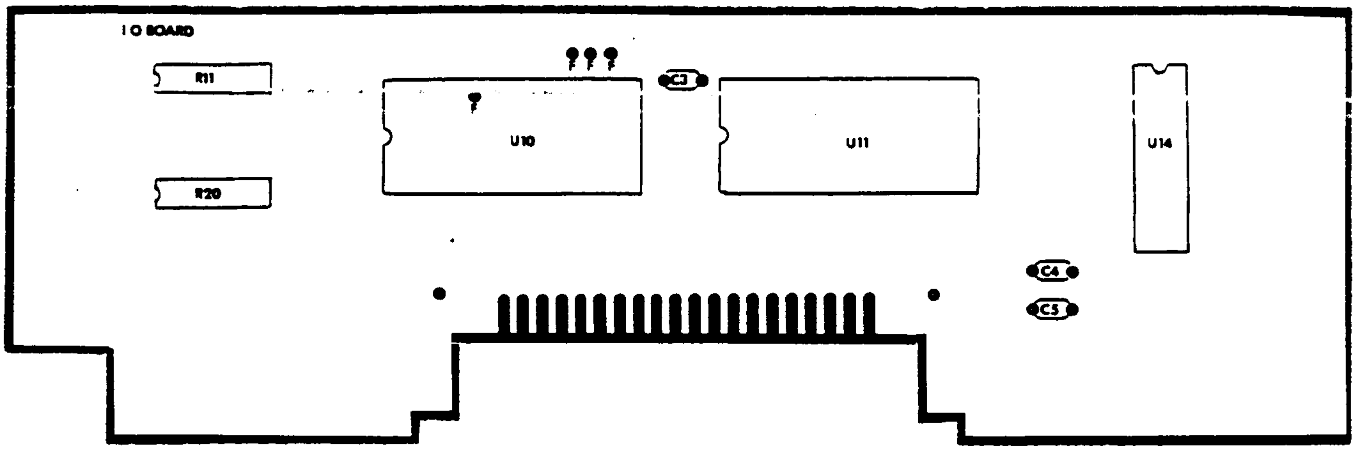

Figure 2-5 Component Layout of the I/O Board

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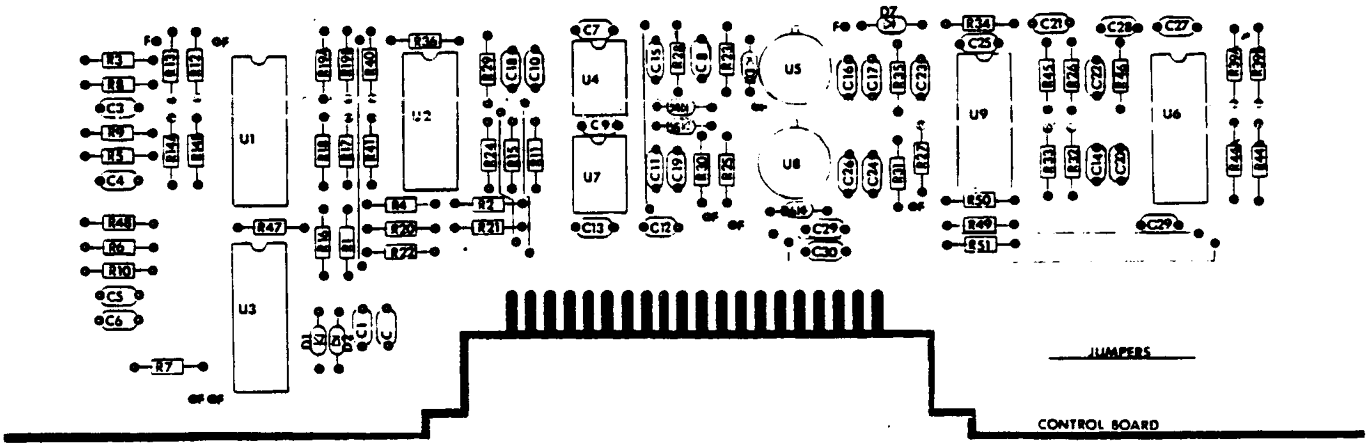

Figure 2-6 Component Layout of the Control Board

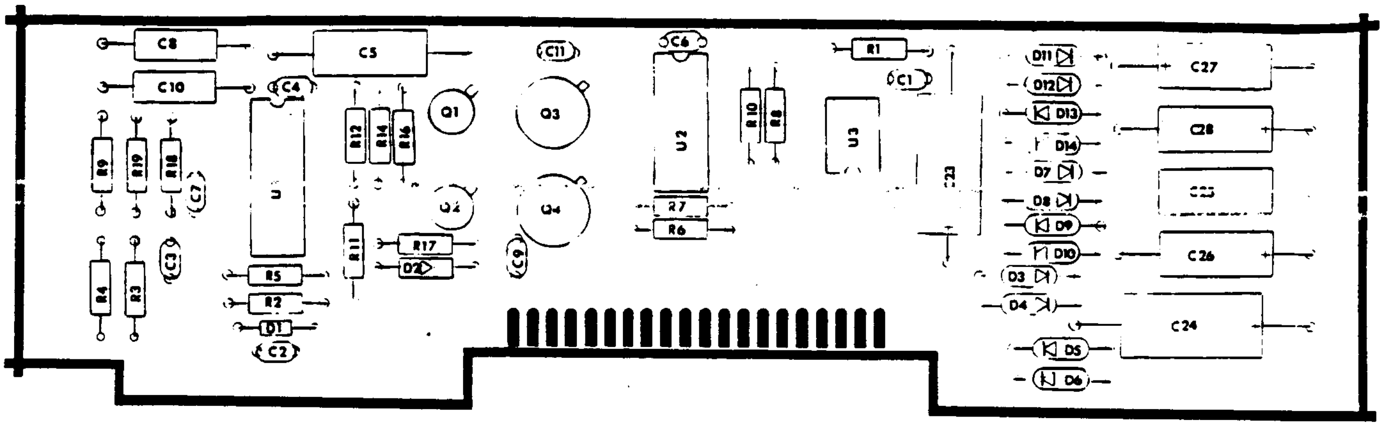

Figure 2-7 Component Layout of the H. V. Control Board

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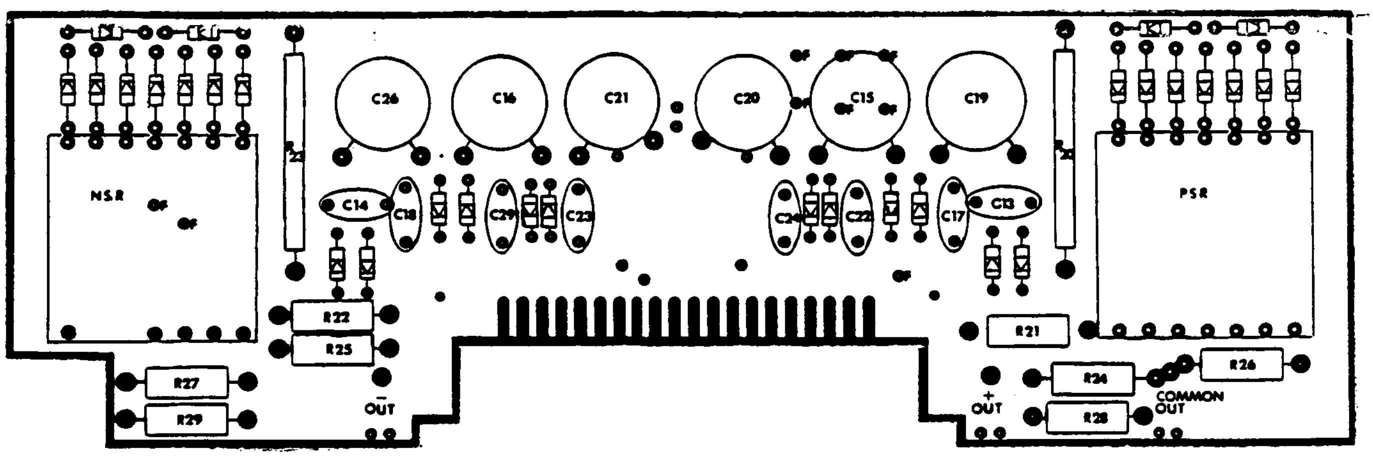

Figure 2-8 Component Layout of the H. V. Board

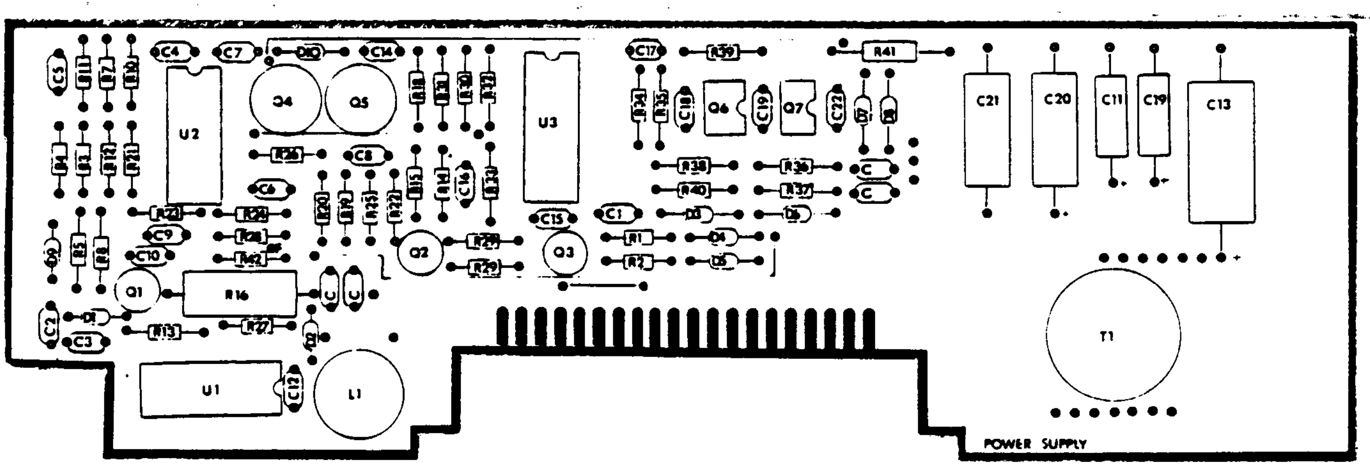

Figure 2-9 Component Layout of the Power Supply Board

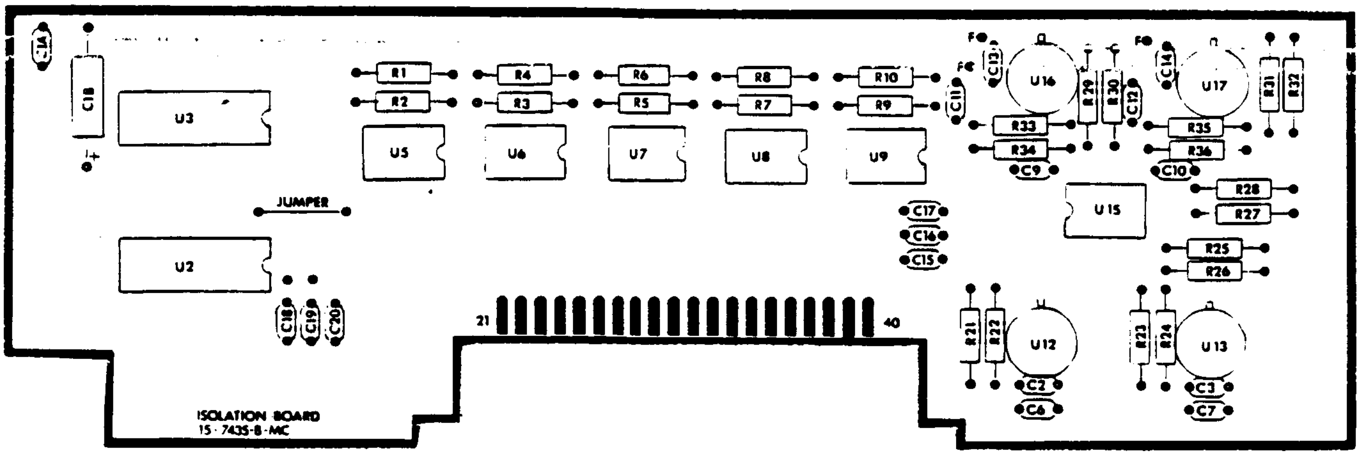

Figure 2-10 Component Layout of the Isolation Board

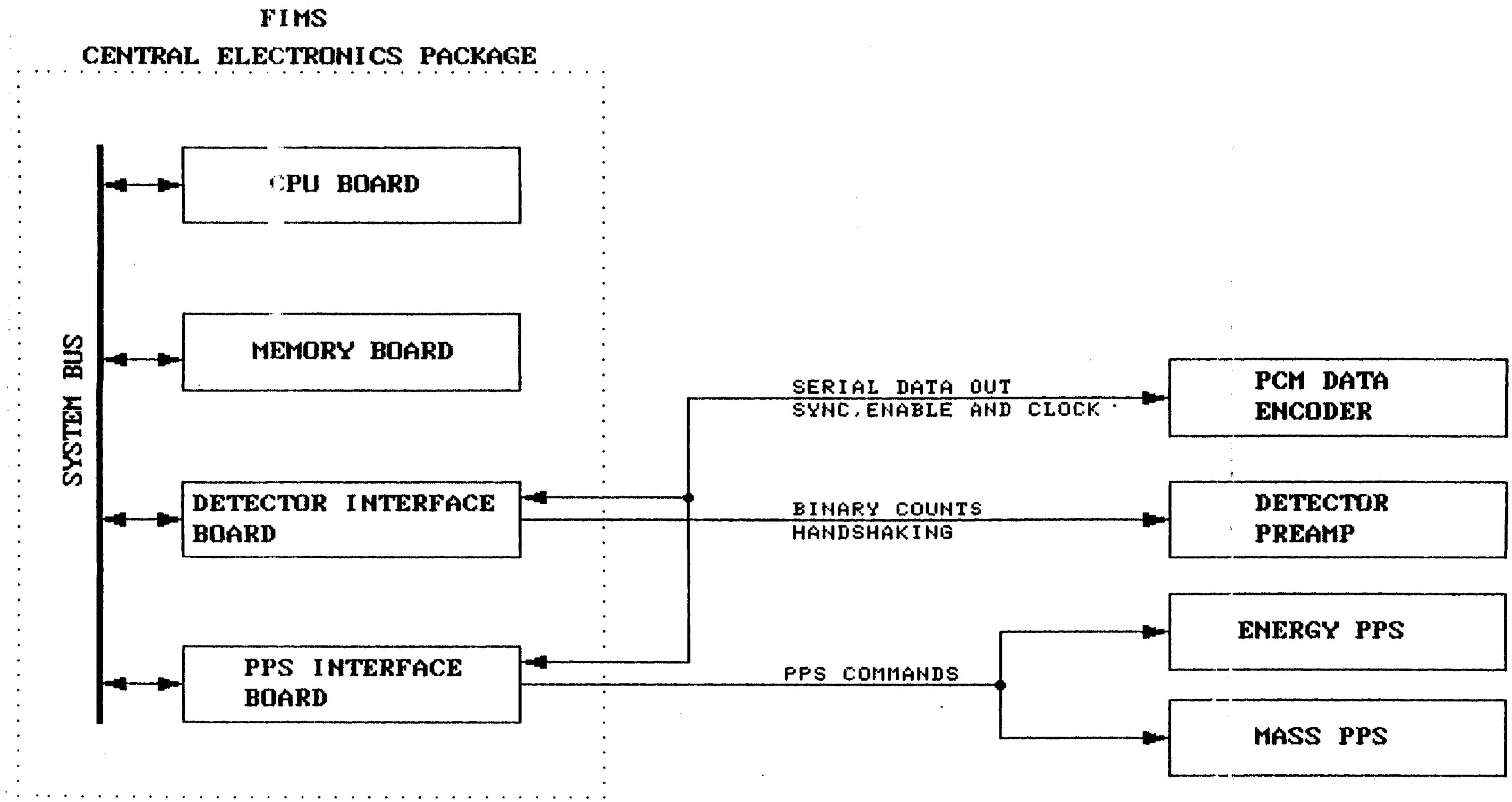

Figure 2.3-1 FIMS CEP Block Diagram

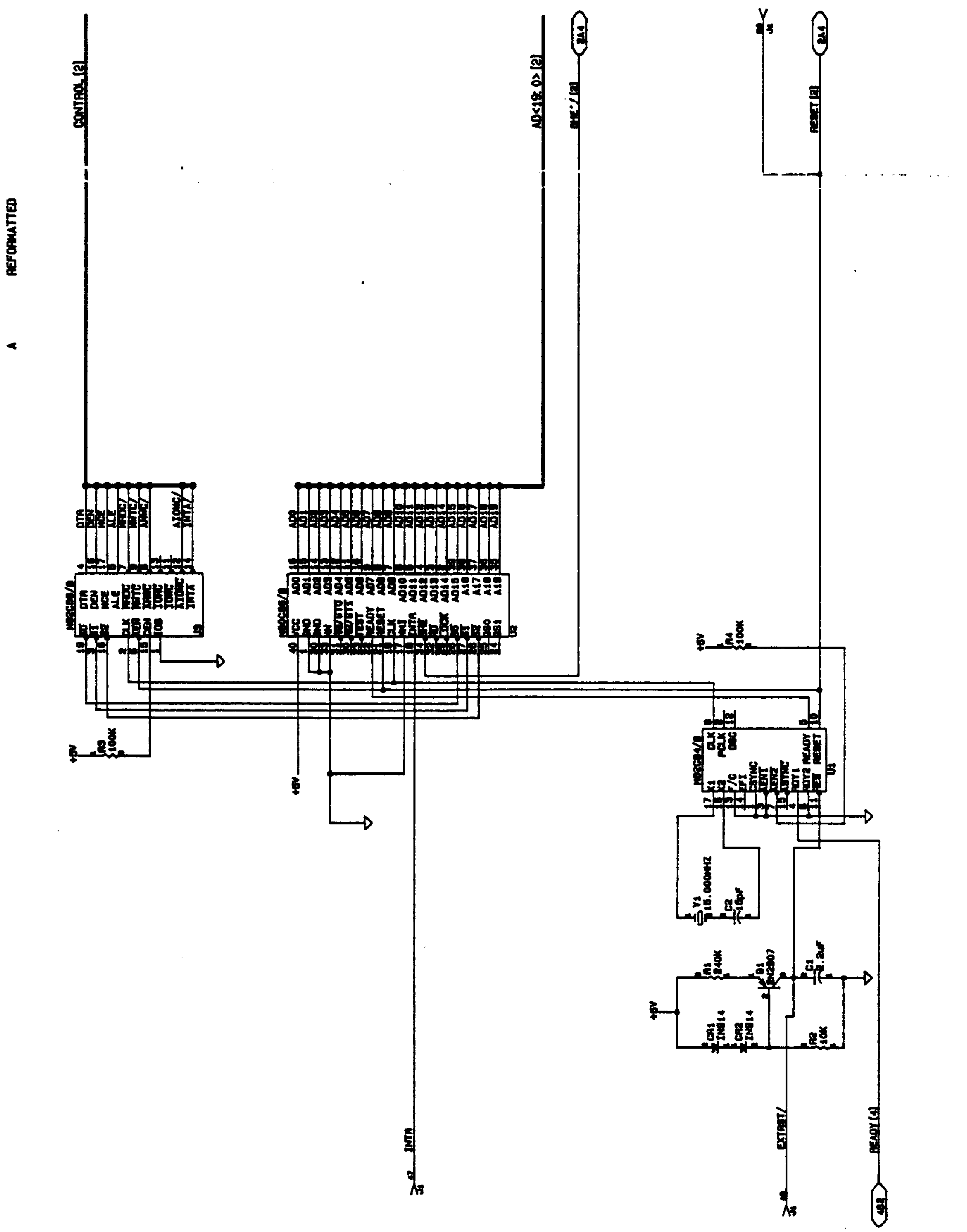

Figure 2.3-2

FIMS CENTRAL PROCESSOR CARD

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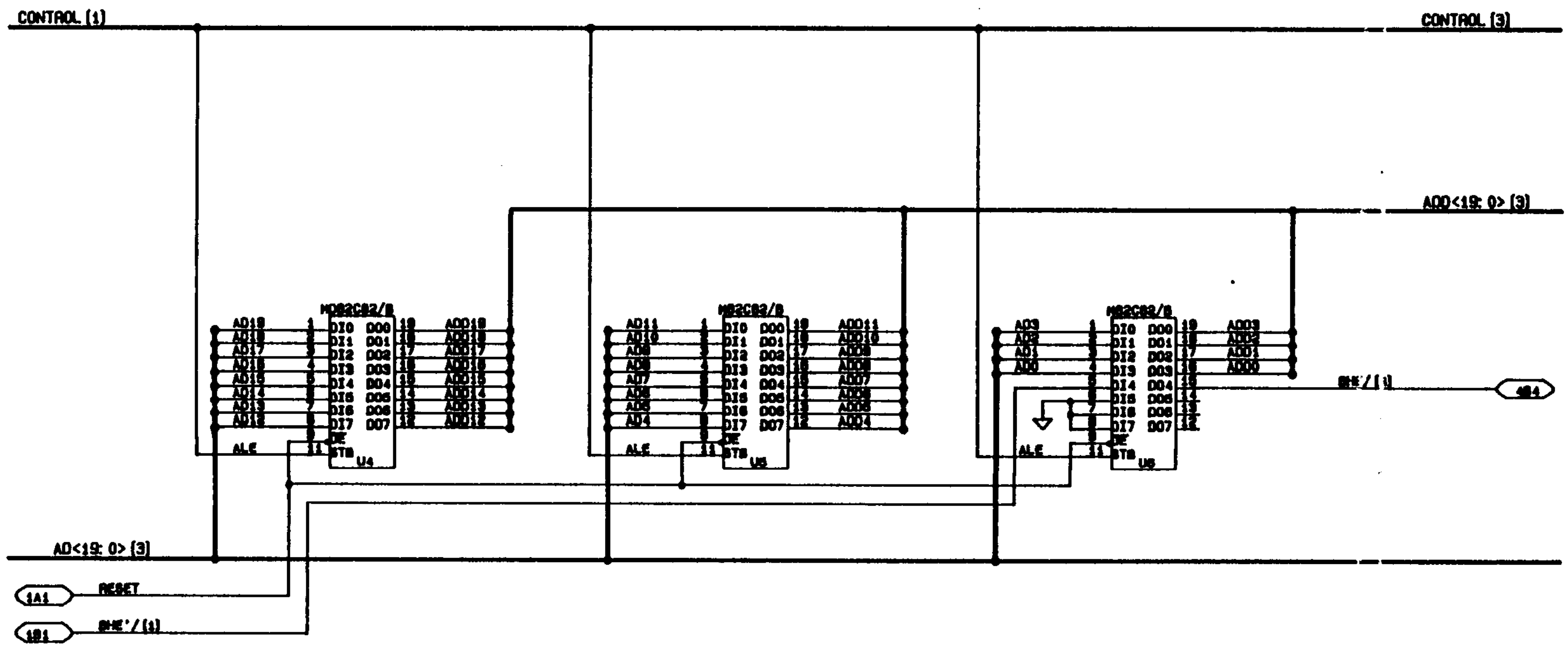

ADDRESS BUS DEMULTIPLEXER SECTION

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Figure 2.3-3

FIMS CENTRAL PROCESSOR CARD

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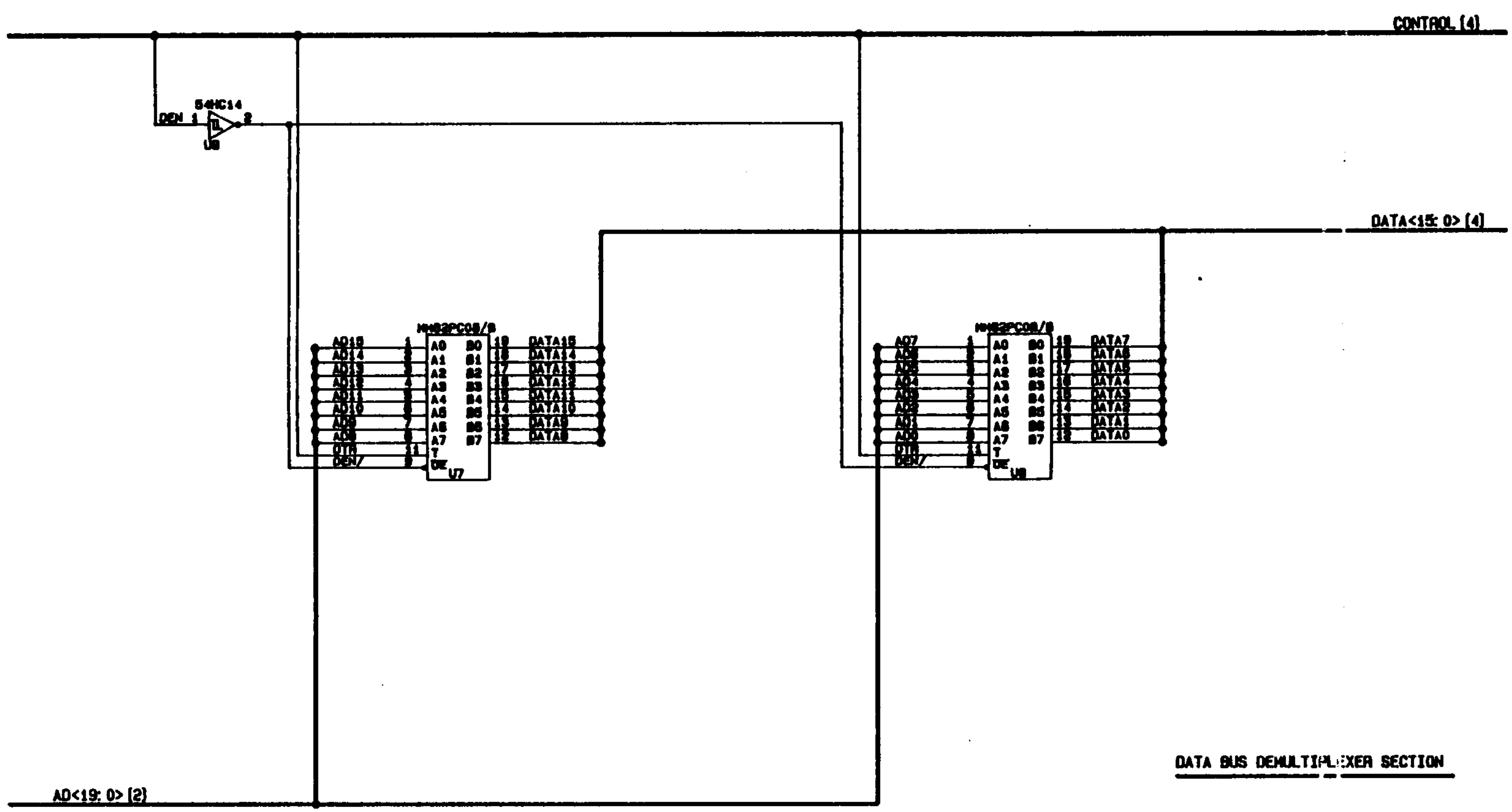

DATA BUS DEMULTIPLEXER SECTION

Figure 2.3-4

FIMS CENTRAL PROCESSOR CARD

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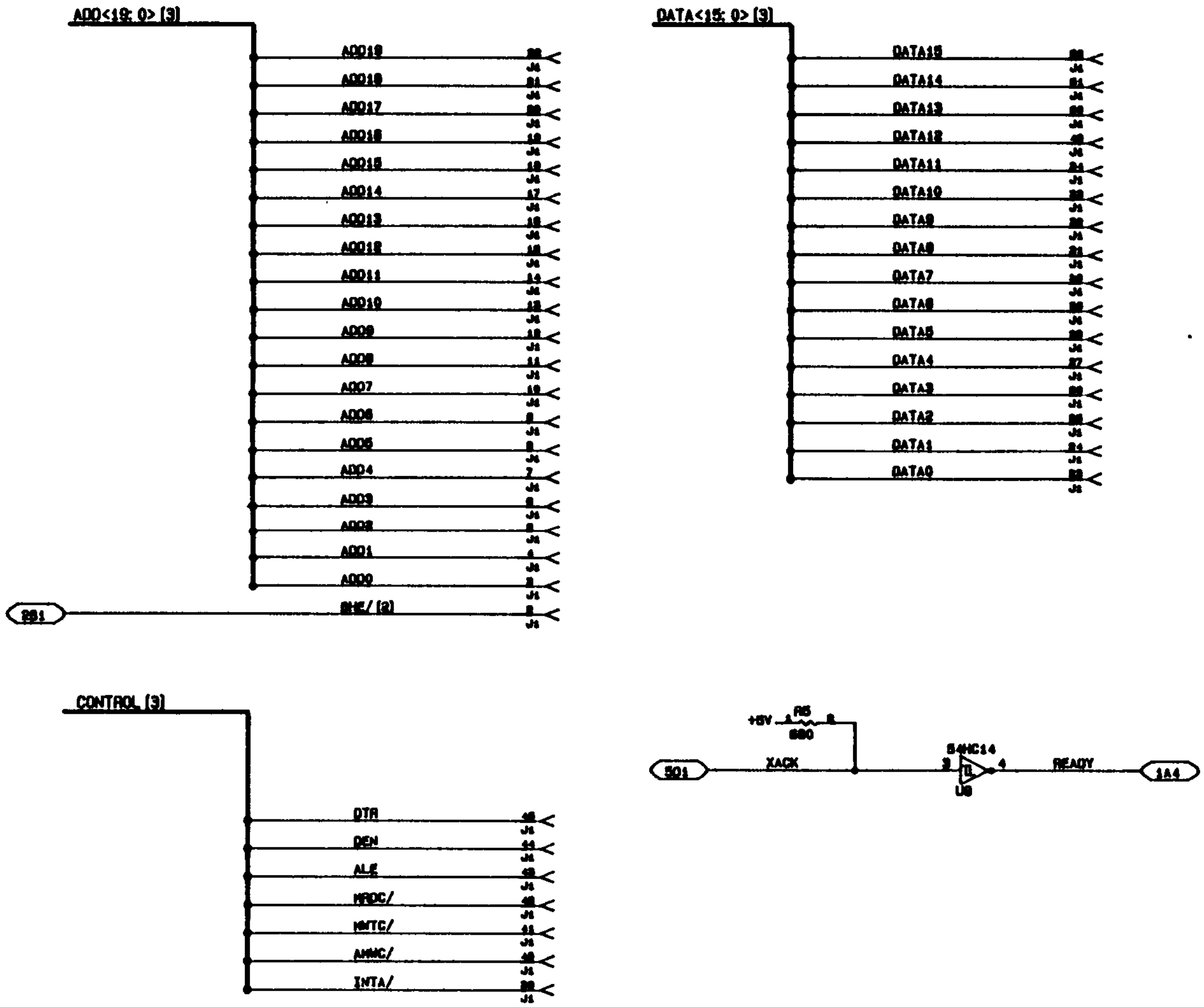

FIMS CENTRAL PROCESSOR CARD

Figure 2.3-5

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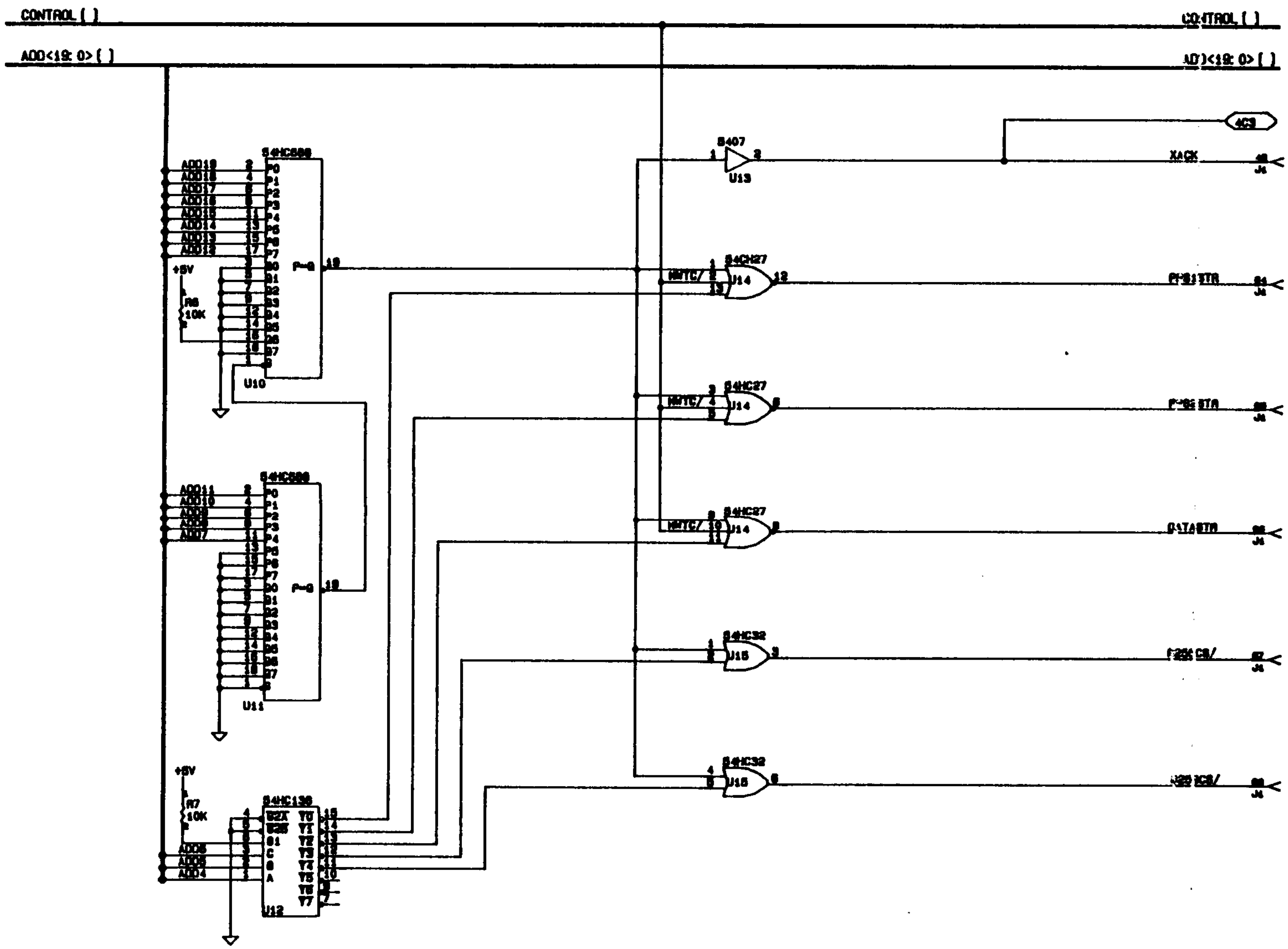

FIMS CENTRAL PROCESSOR CARD

Figure 2.3-6

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address bits add4-add6 are decoded in order to generate unique select lines for the individual I/O devices. Decoded addresses are then qualified against memory read and write control signal to produce the various strobe and enable signals needed for operation by the other 3 boards. Figure 2.3-6 shows the manner in which these several control signals are generated.

2.3.2 Control and Data Memory

Figures 2.3-7 through 2.3-9 show the circuitry used to provide the FIMS CEP with both control and data memory. As a media for storing software instructions, CMOS u.v. erasable/programmable read only memory (EPROM) devices are used. Between the two 27C64 EPROMs used in the CEP, a total of 16k bytes of program storage space is made available.

For data memory and program stack operations, CMOS static random access memory (RAM) is used. Figures 2.3-8 shows the circuitry used to produce a total of 4k bytes of ram for the CEP. Address recognition for the memory board is managed with 54HC688s as seen in Figures 2.3-7 and 2.3-8. Because of the short operating time of the FIMS instrument no attempt has been made to implement error detection/correction on control or data memory.

2.3.3 Program Power Supply (PPS) Interfaces

Figures 2.3-10 through 2.3-14 show the circuitry used to provide an interface between the CEP and the PPS's. Commands for the PPSs are latched in CMOS octal latches as shown in Figures 2.3-11 and 2.3-12. The strobe signals used by the latches to actually trap the PPS command words off of the system bus are produced on the CPU board itself as described earlier. Reference is made to the signal labeled "PPS1STR" in Figure 2.3-11 as an example of a PPS command strobe signal.

To provide electrical drive capability to the octal latches storing the 10 bit command words used by each of the 2 PPS's, CMOS hex inverters are used. Examples of these interface buffers can be seen in Figures 2.3-11 and 2.3-12. It should be noticed that the logical interface to both of the PPS's is through the 10 least significant bits of the CPU's 16 bit data bus.

In addition to providing a logical and physical interface to the PPS's, the PPS interface board also provides command monitoring capability. Figures 2.3-13 and 2.3-14 show the digital circuitry used to latch the PPS command words into parallel/serial shift registers. The same strobe signal used to latch the PPS command into the appropriate output buffer is also used to latch the command into the input section of a 10 bit shift register.

The shift registers used for the 2 PPS command interfaces can be clocked out by the rocket's p.c.m. telemetry interface as required. Attention is called to the fact that interfaces to the rocket's telemetry system are true differential with all output signals driven by high current line drivers and all inputs optically coupled.

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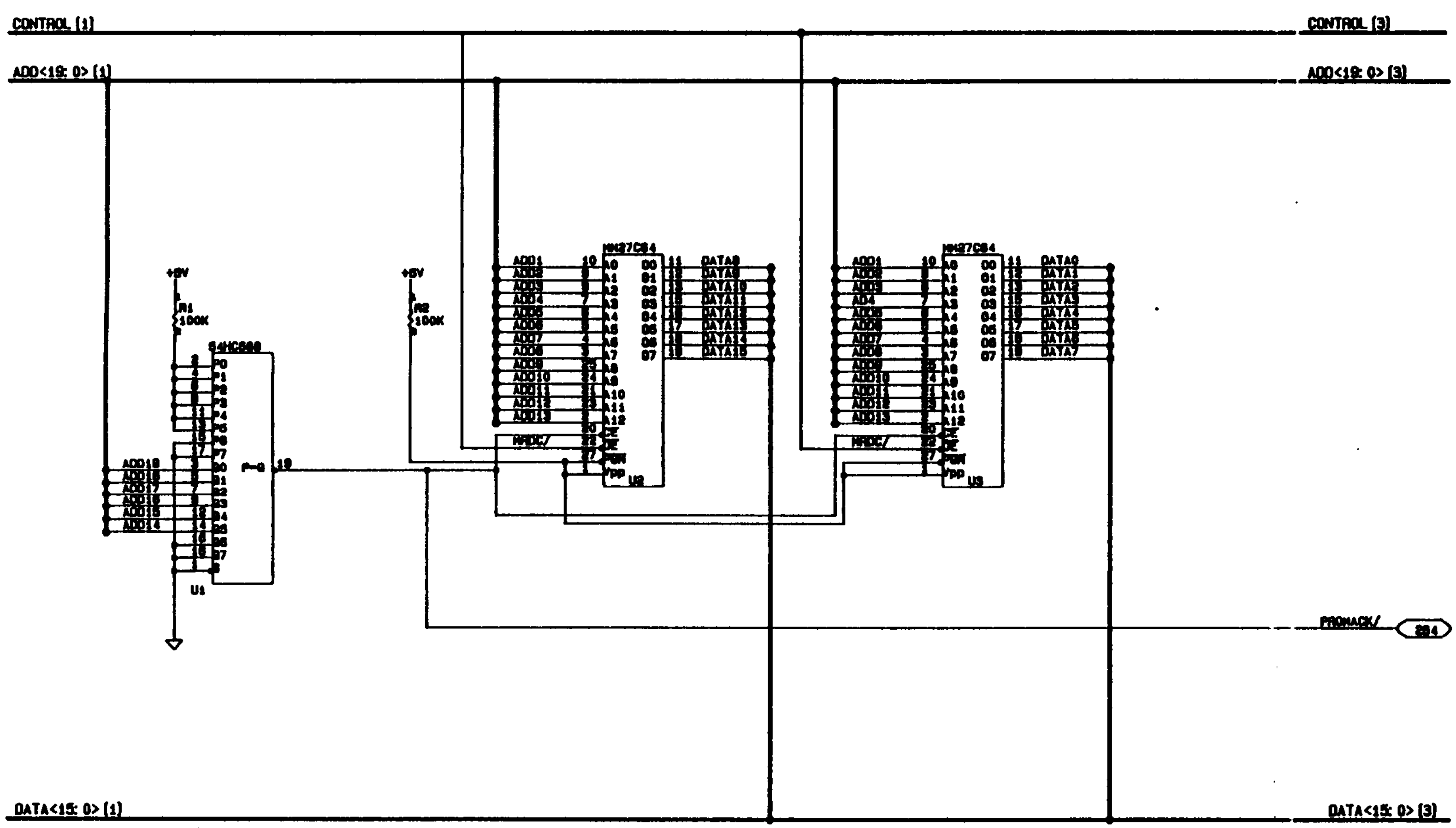

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FINS PROCESSOR MEMORY BOARD

Figure 2.3-7

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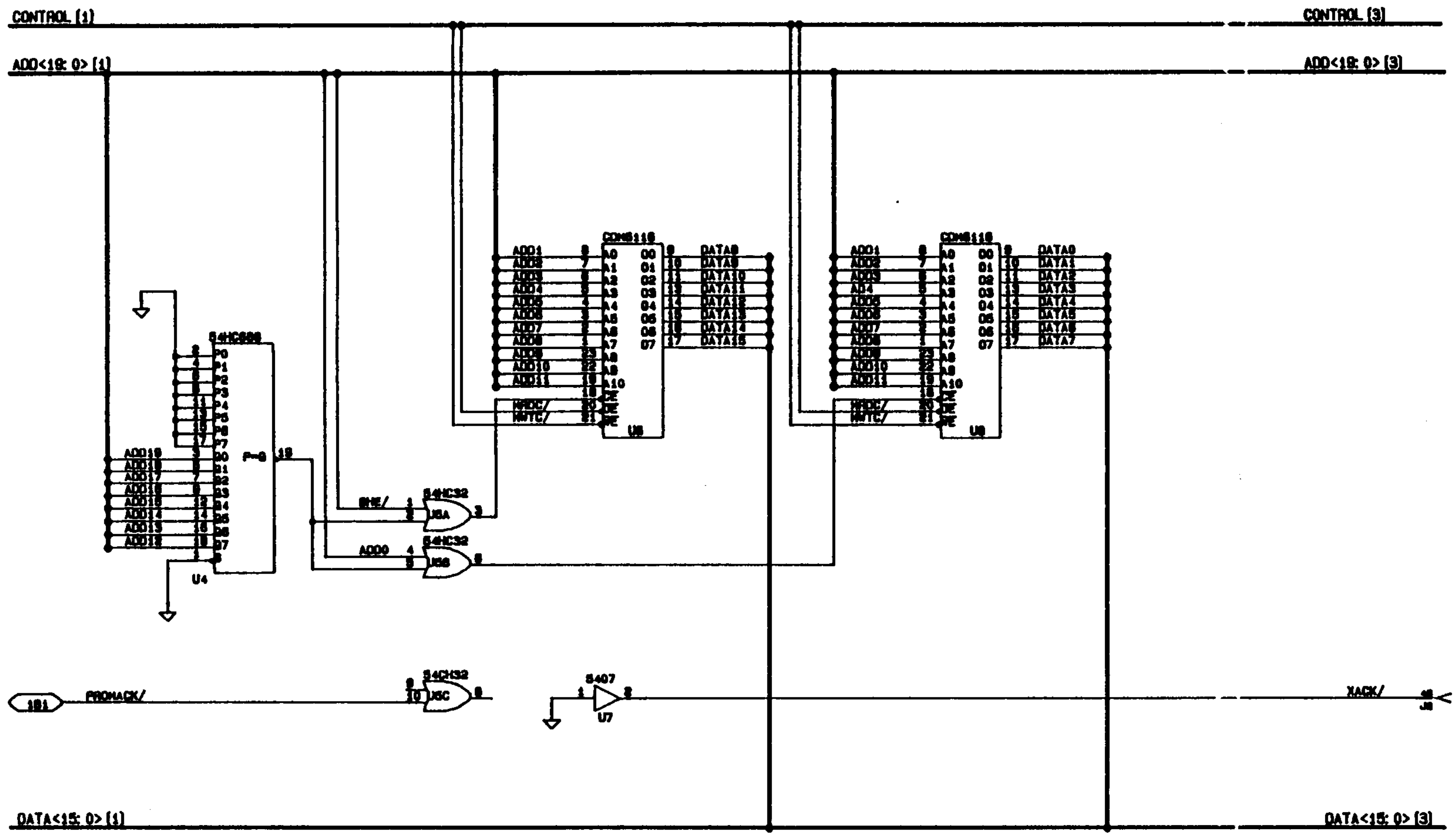

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Figure 2.3-8

FIMS PROCESSOR MEMORY BOARD

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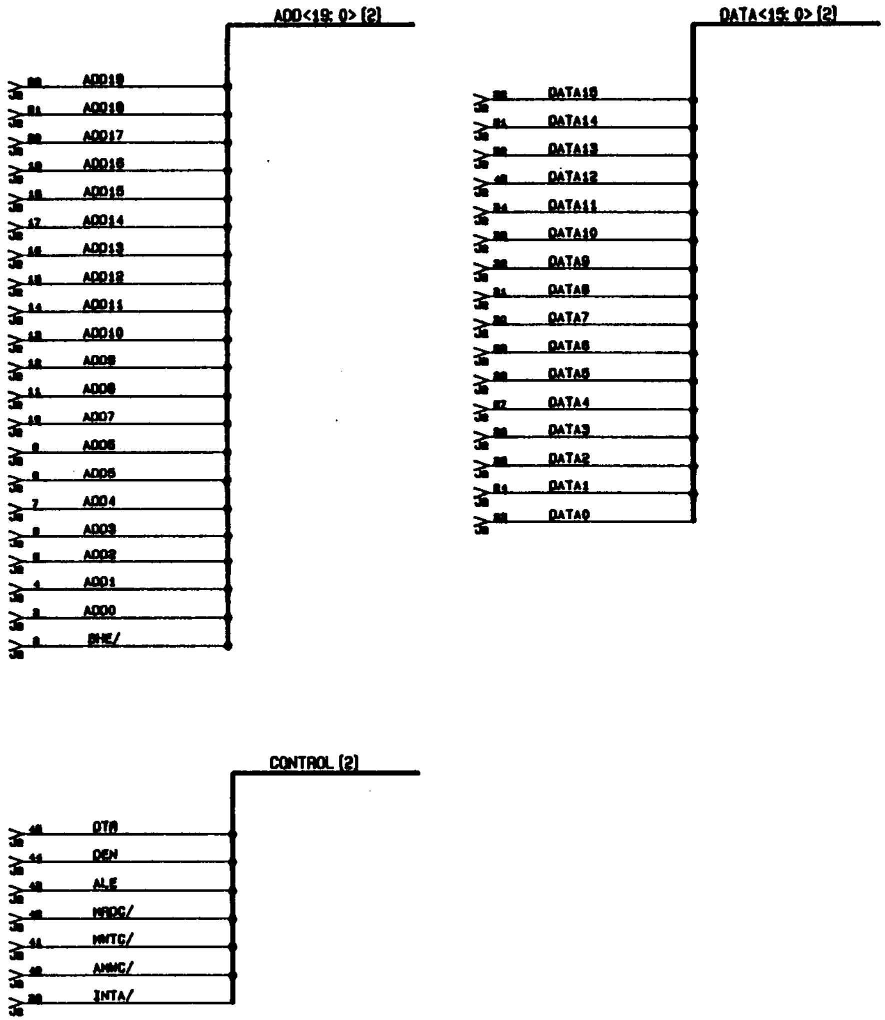

FIMS PROCESSOR MEMORY BOARD

Figure 2.3-9

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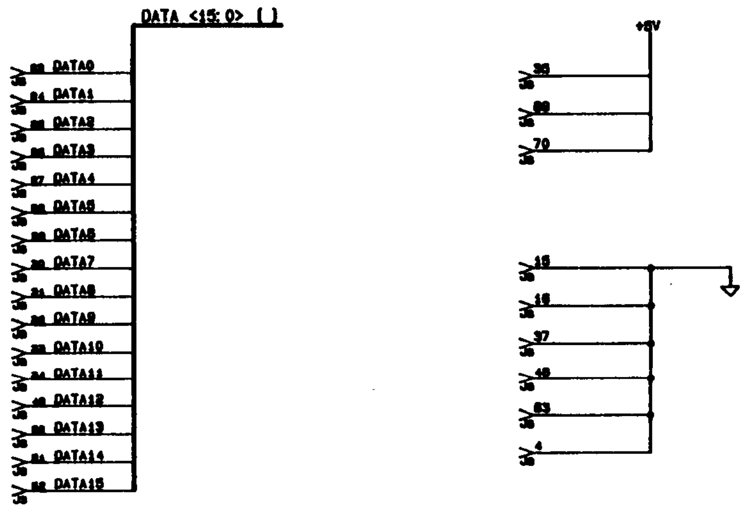

Figure 2.3-10

FIMS PROCESSOR PPS INTERFACE BOARD

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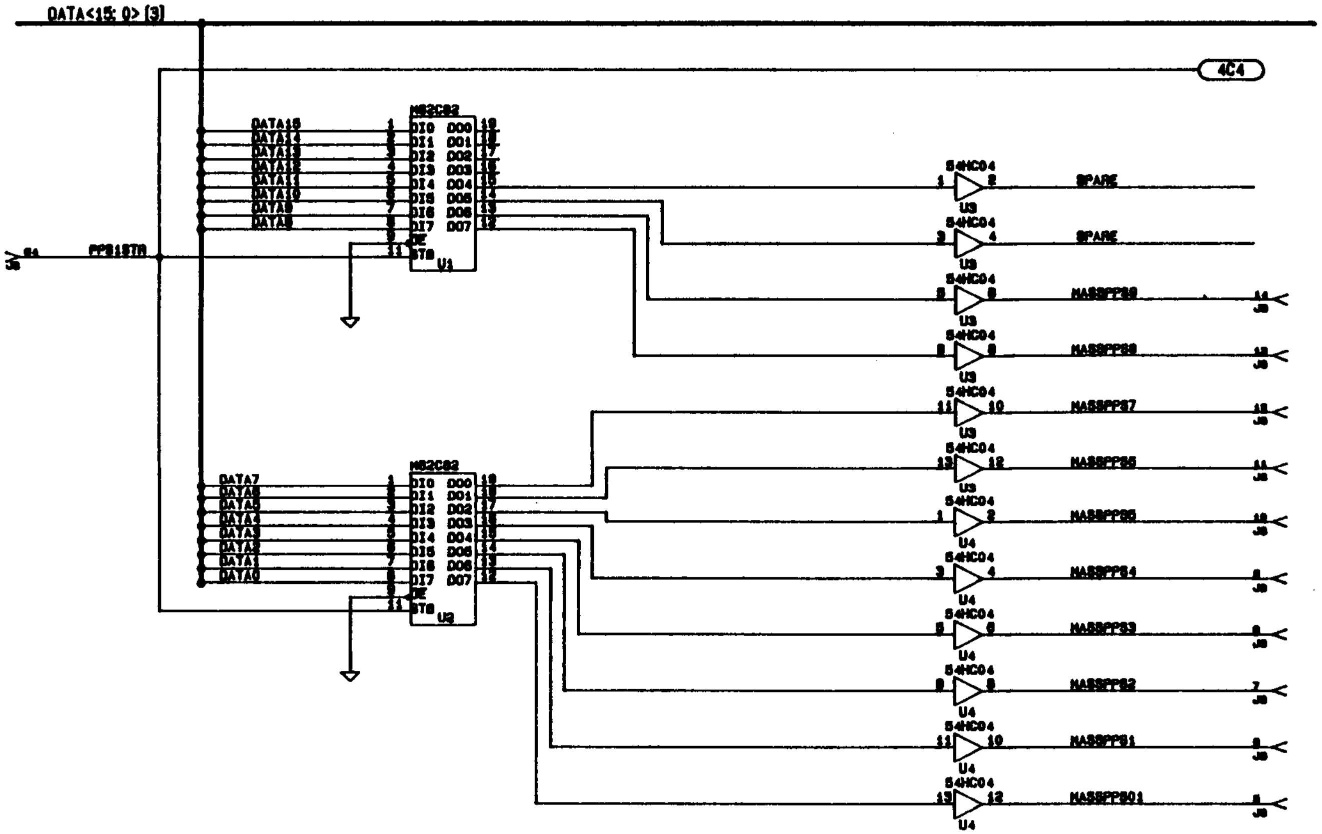

Figure 2.3-11

FIMS PROCESSOR PPS INTERFACE BOARD

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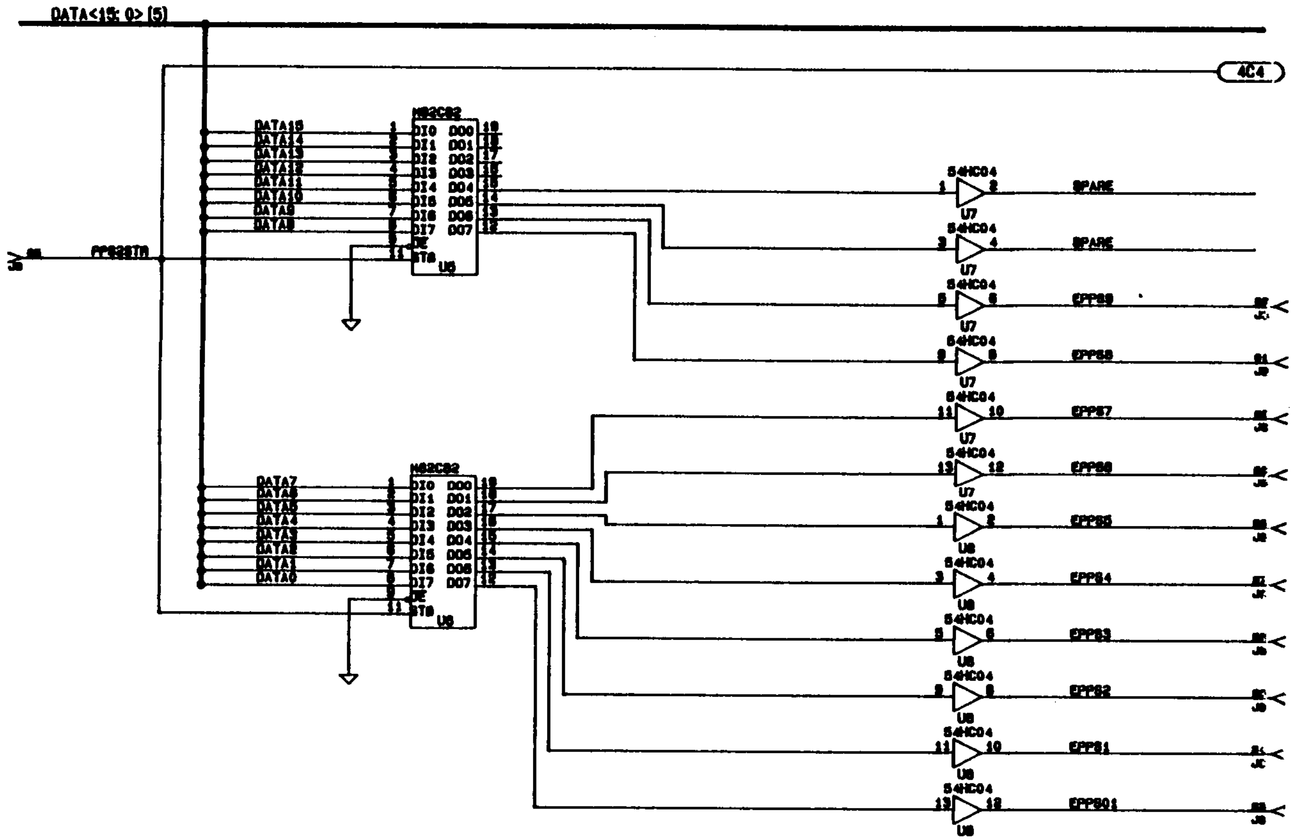

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Figure 2.3-12

FI.IS PROCESSOR PPS INTERFACE BOARD

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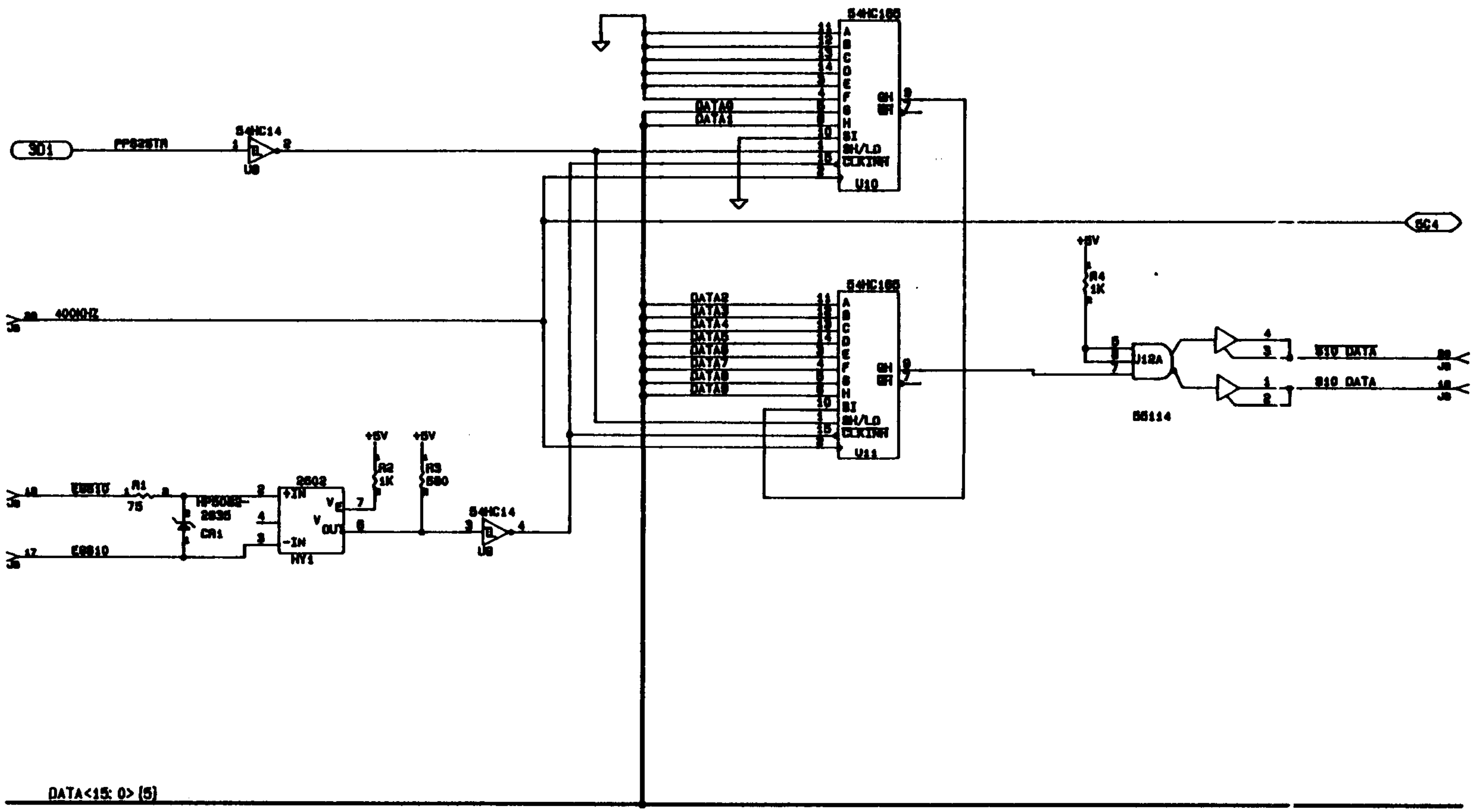

I.S PROCESSOR PPS INTERFACE BOARD

Figure 2.3-13

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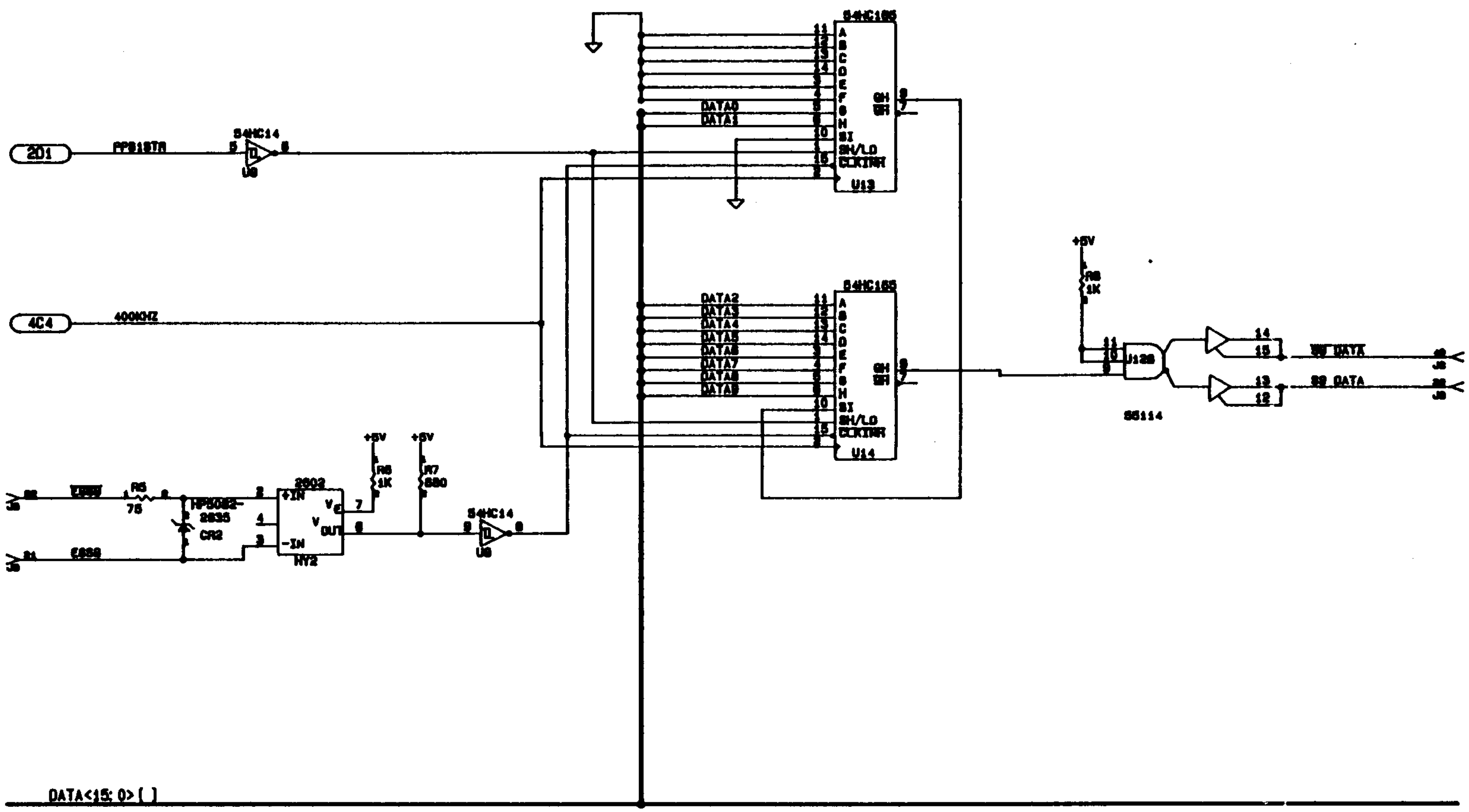

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Figure 2.3-14

FIPS PROCESSOR PPS INTERFACE BOARD

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2.3.4 Detector Interface

Shown on Figures 2.3-15 through 2.3-19 are the electrical schematics of the interfaces between the CEP and the analyzer's detector subsystem. Two Amperex B413-BL channel electron multipliers (CEM) (Section 2.1) with associated preamplifiers and a 2 channel CMOS hybridized binary counter are used in the detector subsystem. Ions exiting the E X B analyzer will be detected by the CEMs producing pulses which will in turn be counted by the binary counter mentioned above. The CEP acquires detector counts from this hybridized counter through an 8 bit parallel interface shown in Figures 2.3-14 and 2.3-15. A handshaking systems is employed to assure proper data transfer between the CEP and the detector subsystem. Figure 2.3-19 is a timing diagram of this handshaking.

The 80C86 microprocessor communicates with the detector interface through an 82C55 programmable peripheral interface (PPI) device. The handshaking scheme described above is carried out using port c output bits from the 82C55. Although somewhat slow, this approach to handshaking uses very few components.

2.3.5 Software Operation

As mentioned earlier, the FIMS instrument is controlled and monitored by a 16 bit CMOS microprocessor. A simplified flowchart of the software operation of the microprocessor is shown in Figure 2.3-20. The controller is completely interrupt driven, depending on timing interrupts generated by telemetry interface circuitry for operation. Minor frame (0.8 ms) and major frame (25.6 ms) rate interrupts synchronize the operation of the instrument to the data acquition rate of the telemetry system.

As each major frame rate interrupt is received, the microprocessor runs a software task which builds a pointer into a table of commands used by the energy analyzer's PPS. As seen in the flowchart, the process of building and transmitting energy PPS commands continues until a complete energy sweep ranging from lev/q to 2115 ev/q has been completed. Normally, an energy sweep is completed in 1.1 seconds. Table 2.3-1 shows the energy levels visited during a normal energy sweep.

At the completition of an energy sweep a new ion species is selected (via mass PPS commands) for measurement and the energy analysis begun again. Table 2.3-2 shows the atomic masses of the species examinedand the order in which they are sampled. When all species have been analyzed in the order shown in Table 2.3-2 the software recycles and begins the "normal sweep" again.

Because of the cross coupling between the energy/charge and mass/charge analyzers it is necessary to make minor corrections to the mass PPS setting for each new energy command. It is therefore oversimplified to think that in normal operation only the energy PPS is stepped each major frame.

Reference has been made to a "normal sweep" in the paragraphs above in order to differentiate between the standard sweep and the fine mass resolution sweep which is also programmed into the 80C86 software. The phrase

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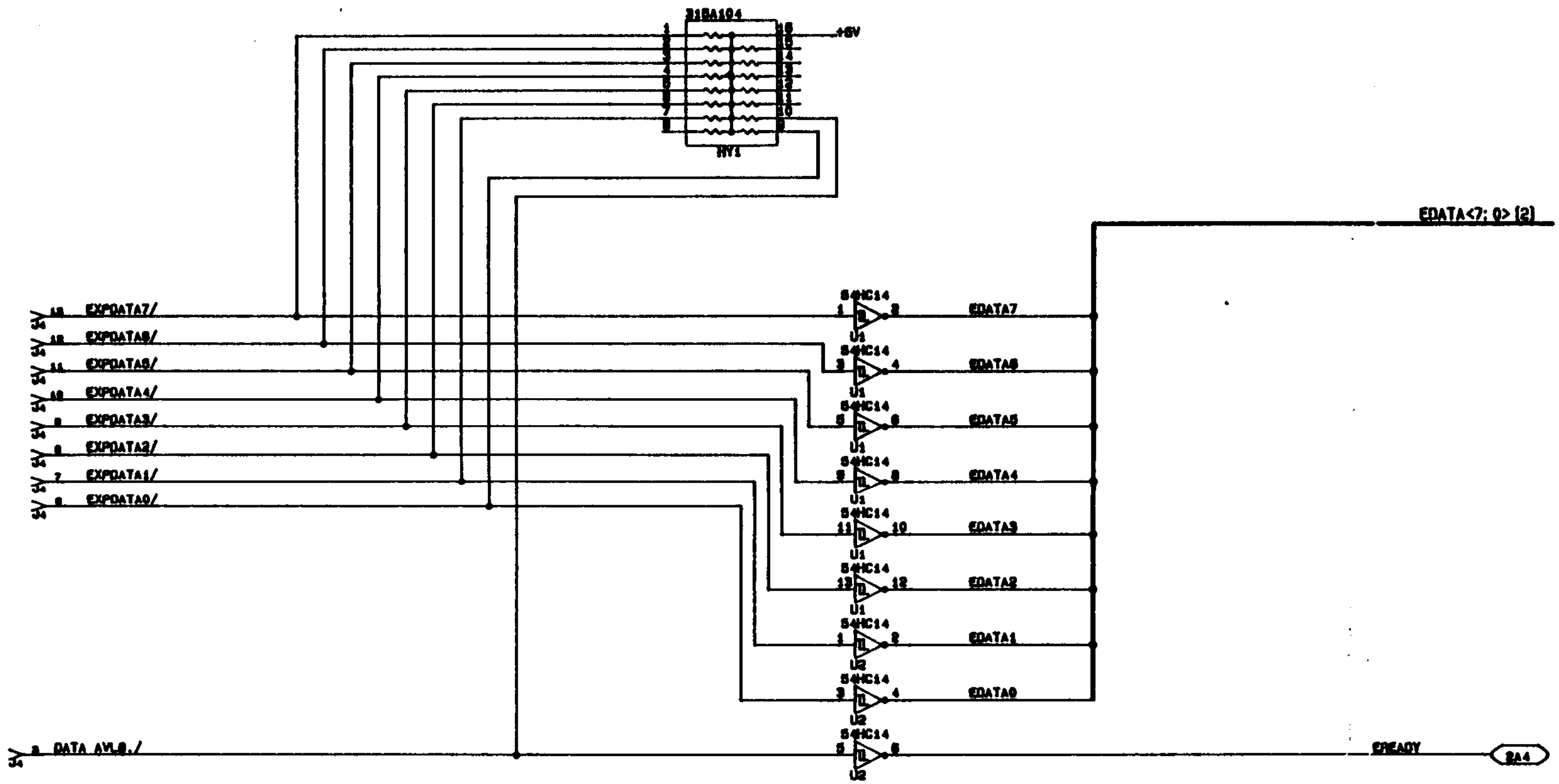

FIM; PROCESSOR DETECTOR INTERFACE CARD

Figure 2.3-15

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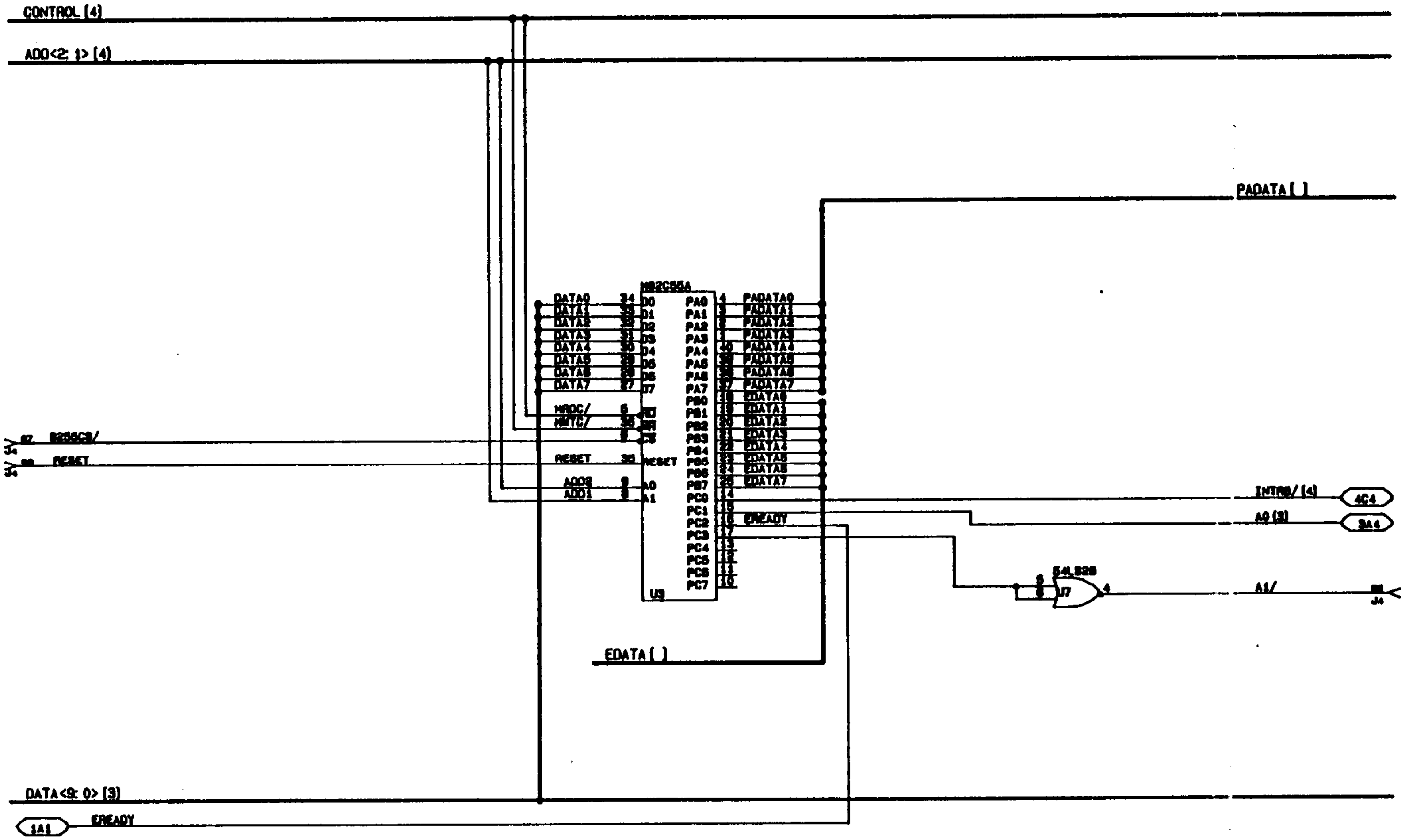

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FINS PROCESSOR DETECTOR INTERFACE CARD

Figure 2.3-16

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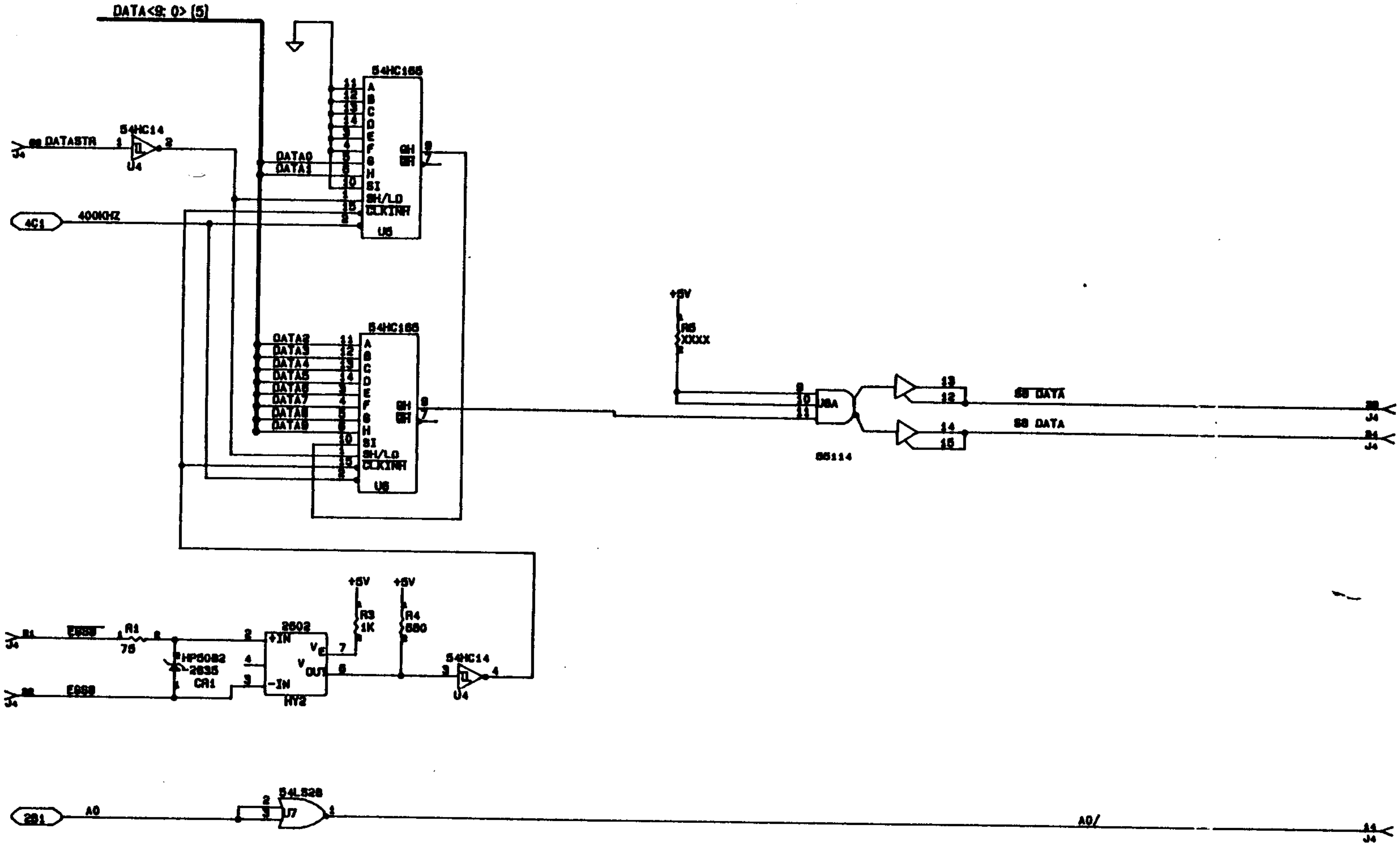

FIMS PROCESSOR DETECTOR INTERFACE BOARD

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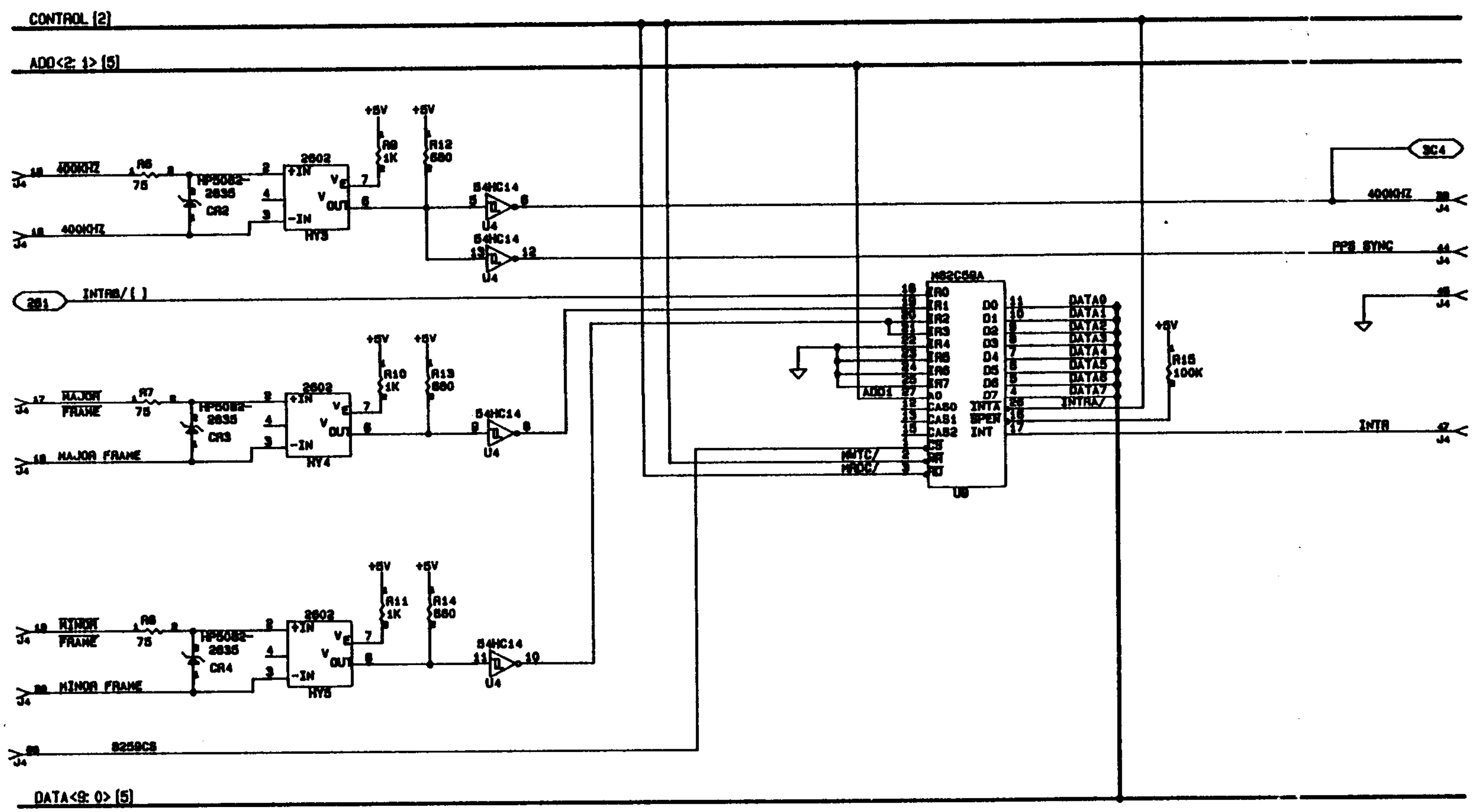
Figure 2.3-17



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FIMS PROCESSOR DETECTOR INTERFACE BOARD

Figure 2.3-18

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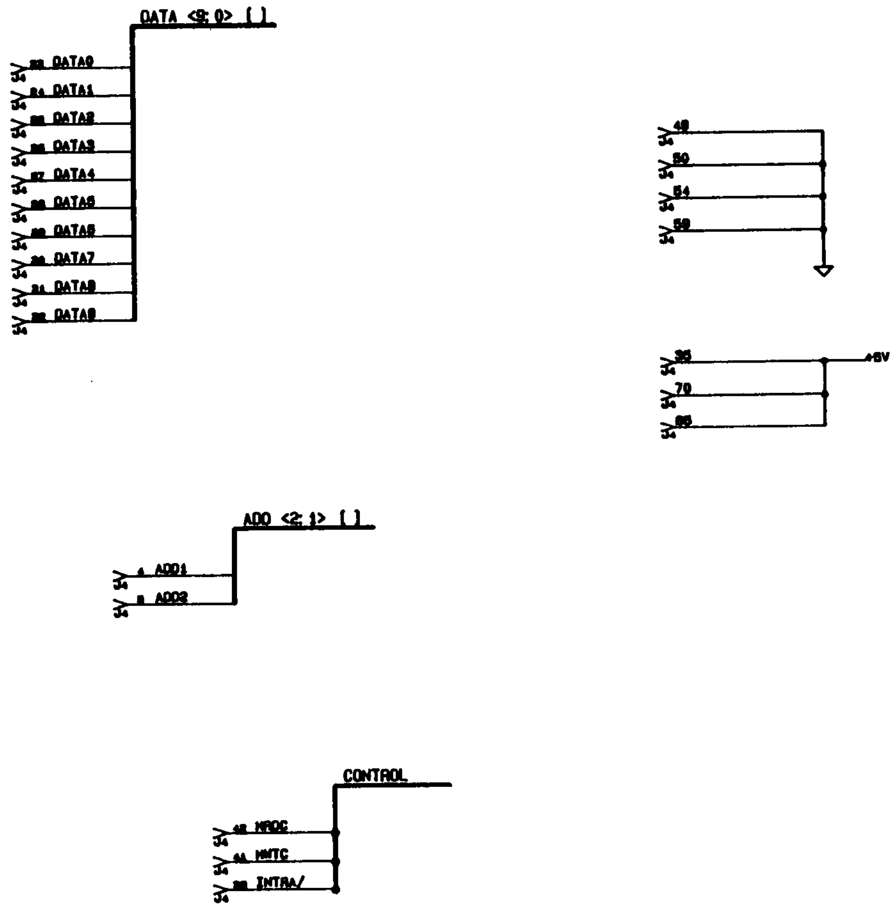

FIMS PROCESSOR DETECTOR INTERFACE BOARD

Figure 2.3-19

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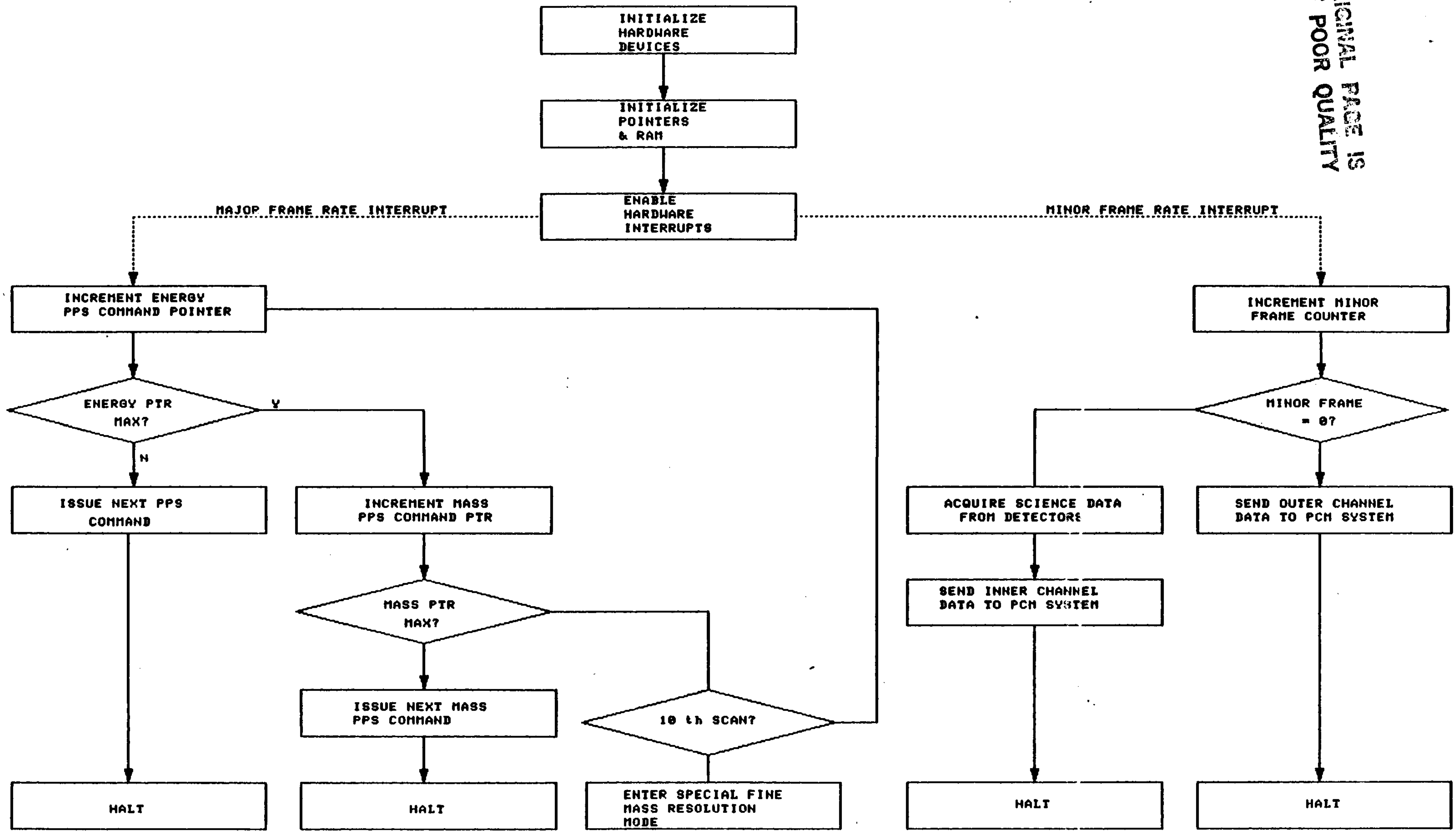

Figure 2.3-20. FIMS Flight Software Flow Chart

TABLE 2.3-1 ENERGY/CHARGE VALUES SAMPLED BY FIMS

STEP NUMBER	ENERGY/CHARGE SAMPLED (ev)
1	1.00
2	1.20
3	1.44
4	1.73
5	2.07
6	2.49
7	2.98
8	3.58
9	4.30
10	5.16
11	6.19
12	7.43
13	8.91
14	10.70
15	12.83
16	15.40
17	18.48
18	22.18
19	26.61
20	31.94
21	38.32
22	45.99
23	55.18
24	66.22
25	79.47
26	95.36
27	114.43
28	137.32
29	164.78
30	197.73
31	237.28
32	284.74
33	341.69
34	410.02
35	492.03
36	590.43
37	708.52
38	850.22
39	1020.27
40	1224.27
41	1469.18
42	1763.02
43	2115.62

TABLE 2.3-2 SPECIES SAMPLED BY FIMS

SPECIES	AMU
NO+	30
O+	16
H+	1
NO+	30
O+	16
He+	4

"normal sweep" is used to indicate an energy/mass set of commands which visits each of the ion species listed in Table 2.3-2 at each of the energy levels shown in Table 2.3-1. A normal sweep thus requires 6.6 seconds to complete. When 9 normal sweeps have been completed the FIMS software is programmed to enter the fine mass resolution mode. In this mode the energy PPS is held fixed for 9 major frame times while the mass PPS is commanded to the 4 closest command settings below and the 5 closest setting above the optimum mass PPS command for each species. In other words, the energy PPS is fixed and the mass PPS sweeps the 9 closest command settings to the optimal for the selected species.

The total number of major frames required to complete the fine mass scan mode is 42 (energy steps) X 9 (mass steps/energy steps) X 6 (species) yielding a product of 2268 commands issued over 58.06 seconds. At the completition of the fine mass scan, the FIMS software resumes the normal scan mode.

A complete set of software listings for the FIMS CEP is contained in Appendix B of this document.

3. LABORATORY CALIBRATION

The FIMS instrument was first calibrated with laboratory electronics and detectors at the SwRI Ion Calibration Facility using hydrogen (H_2^+) and nitrogen (N_2^+) ions at energies from 100eV to 2 keV to test the inner and outer channels respectively. Contour plots, such as Figure 3-1, were used to confirm the analyzer constants for the two sections over the entire energy range. The plot shows voltage on the electrostatic analyzer (x axis) vs. voltage on the electric field plates in the ExB analyzer (y axis) vs. counts (shown as contours) for 2 keV N_2^+. These data give an average dE/E of about 10%. Mass resolution can be demonstrated by taking the separation in voltage applied to the ExB analyzer between masses of interest compared to the spread in voltage for an individual mass. All ions of interest are clearly resolved.

Scans of azimuthal and elevation throughput were also made to confirm the angular range of the instrument. Figure 3-2 shows the acceptance to be ±3° in azimuth and ±12° in elevation. Appendix C is a collection of plots of lab data.

A microchannel plate (MCP) detector was used in order to study exit z position of the particle trajectories vs. incoming ϕ angle, for reference in future missions in which use of an MCP might allow such correlations to be recorded yielding additional information about the pitch angle dependence of the conic events. These data are shown in Figure 3-3, plotted against $\tan\theta$ (solid line) which is the expected acceptance. We hope to investigate the discrepancy further with the next FIMS.

Finally, the flight power supplies (PPSs) and central electronics package (CEP) were integrated with the analyzer and the complete instrument was calibrated using an SC-1 Spacecraft Computer to simulate the rocket's communication buss. Figure 3-4 is a block diagram of the preflight verification configuration. Appendix D contains a table showing a listing of power supply settings for various energies and masses. Instrument performance in the final configuration was confirmed using several input ions.

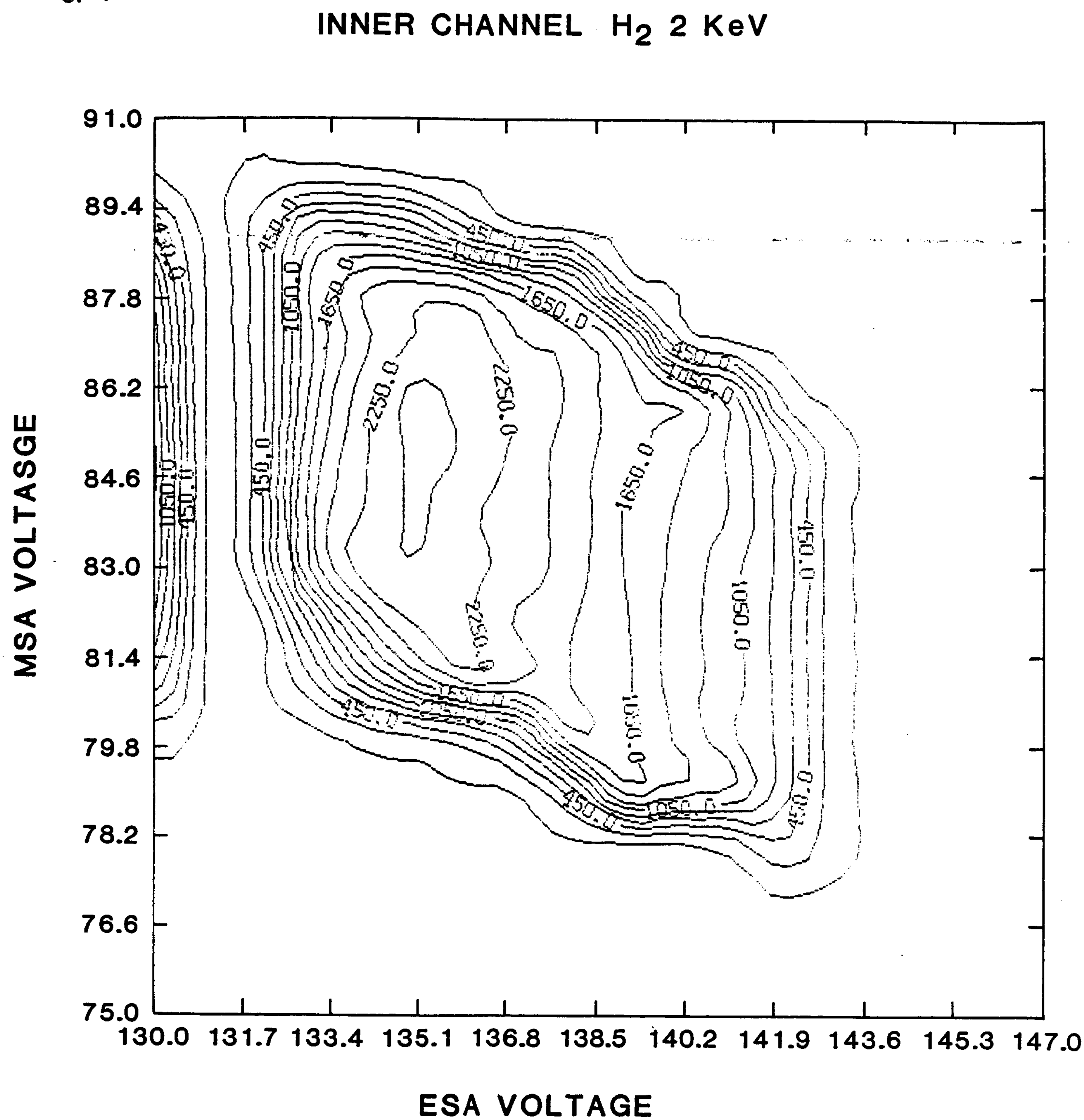
INNER CHANNEL H2 2 KeV
MSA VOLTASGE
91.0
89.4
87.8
86.2
84.6
83.0
81.4
79.8
78.2
76.6
75.0
130.0
131.7
133.4
135.1
136.8
138.5
140.2
141.9
143.6
145.3
147.0
ESA VOLTAGE
450.0
1050.0
1650.0
2250.0

Figure 3-1a

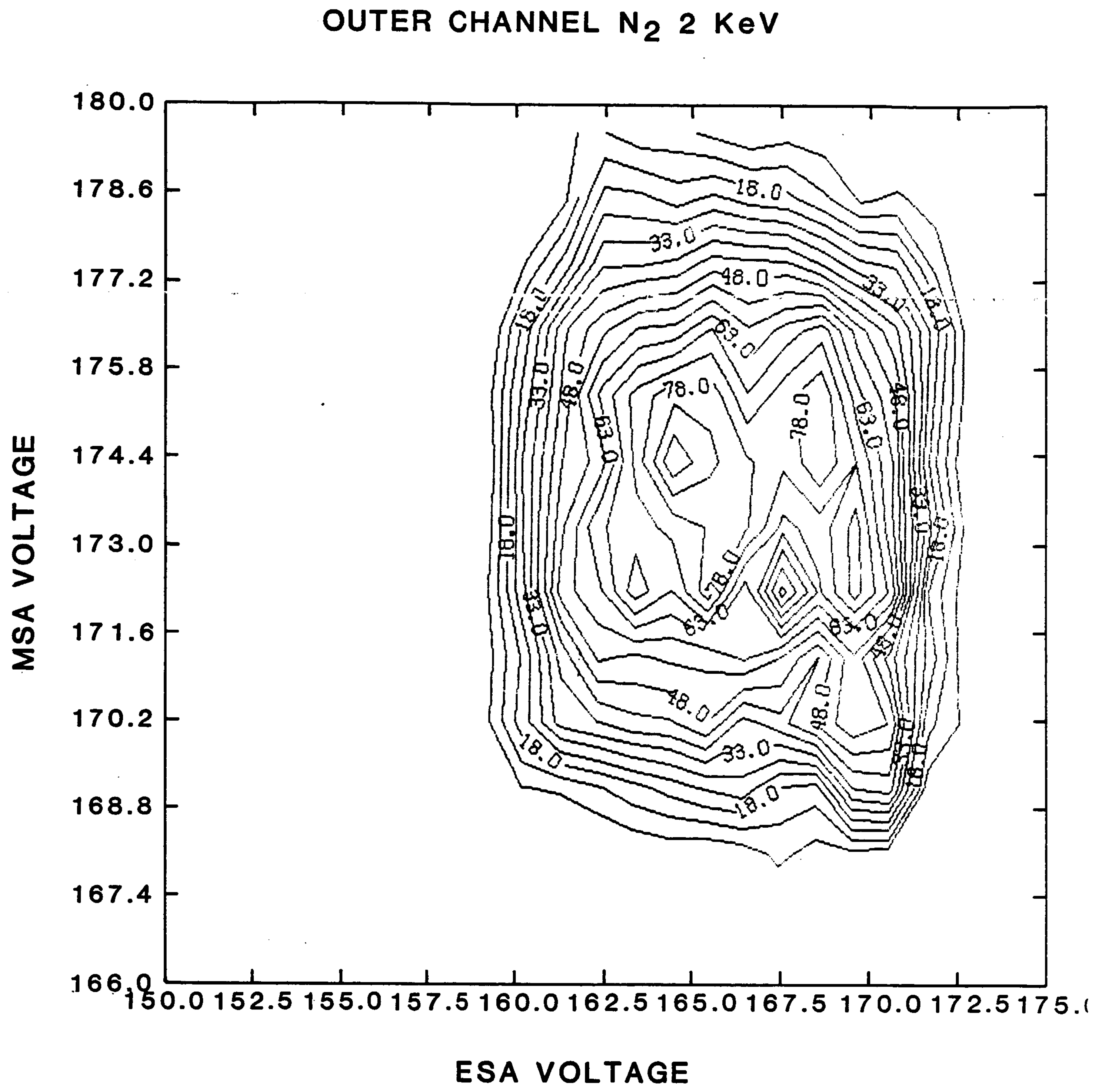
OUTER CHANNEL N_2 2 KeV
MSA VOLTAGE
180.0
178.6
177.2
175.8
174.4
173.0
171.6
170.2
168.8
167.4
166.0
150.0 152.5 155.0 157.5 160.0 162.5 165.0 167.5 170.0 172.5 175.0
ESA VOLTAGE
18.0
33.0
48.0
63.0
78.0

Figure 3-1b

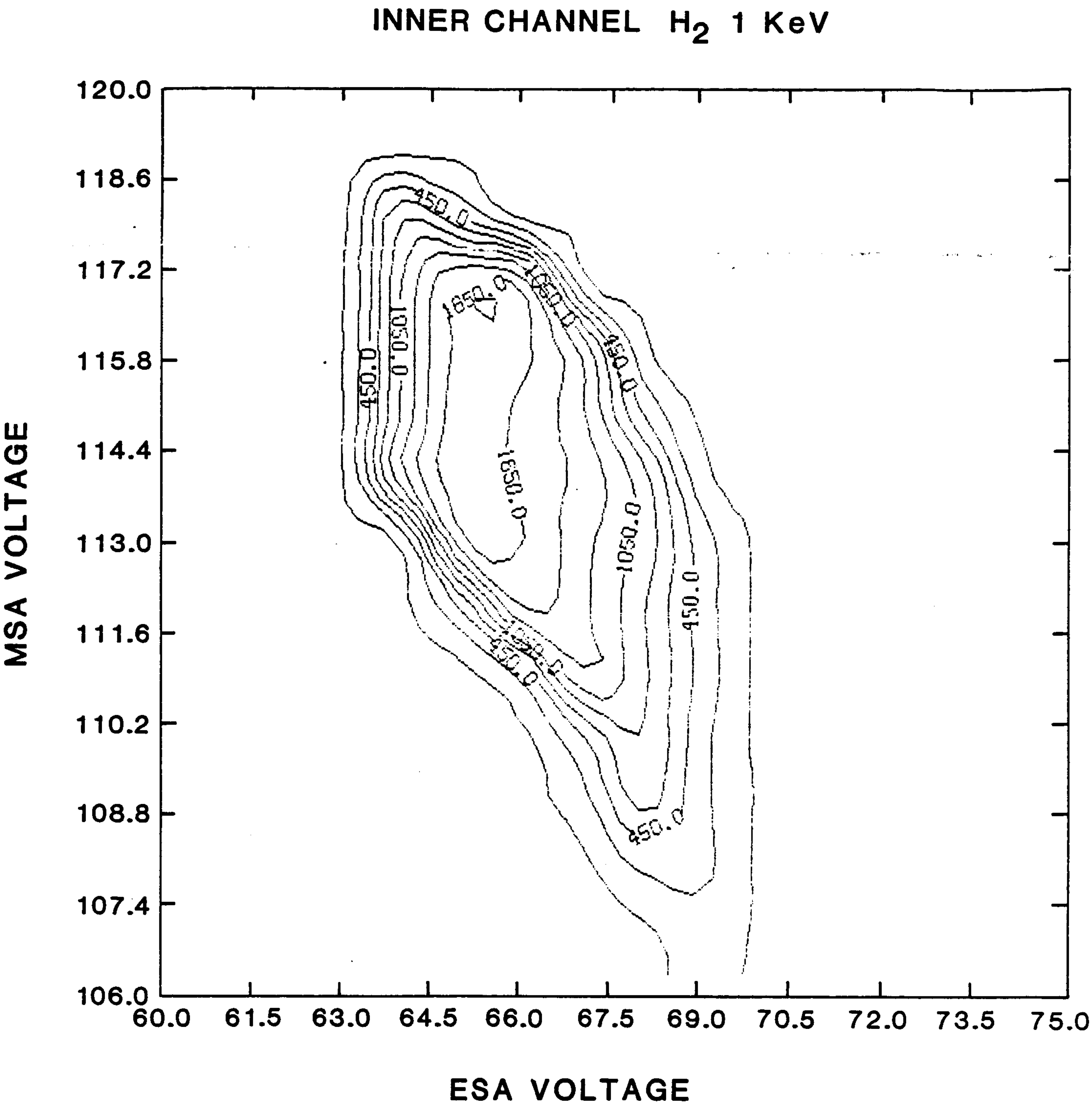
INNER CHANNEL H_2 1 KeV
MSA VOLTAGE
ESA VOLTAGE
120.0
118.6
117.2
115.8
114.4
113.0
111.6
110.2
108.8
107.4
106.0
60.0
61.5
63.0
64.5
66.0
67.5
69.0
70.5
72.0
73.5
75.0
450.0
1050.0
1650.0

Figure 3-1c

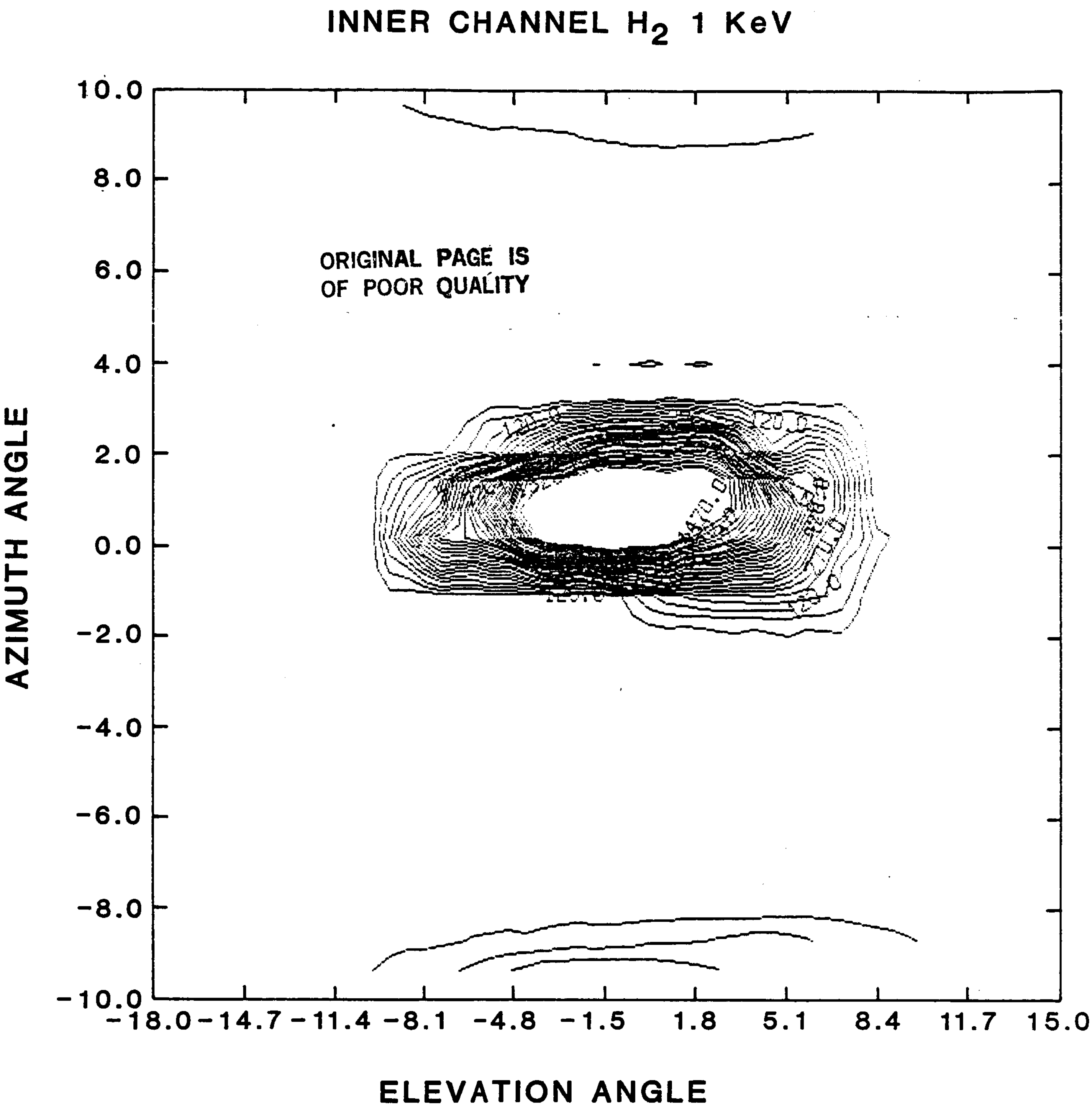
INNER CHANNEL H_2 1 KeV
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-18.0
-14.7
-11.4
-8.1
-4.8
-1.5
1.8
5.1
8.4
11.7
15.0
AZIMUTH ANGLE
ELEVATION ANGLE
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Figure 3-2a

ORIGINAL PAGE IS
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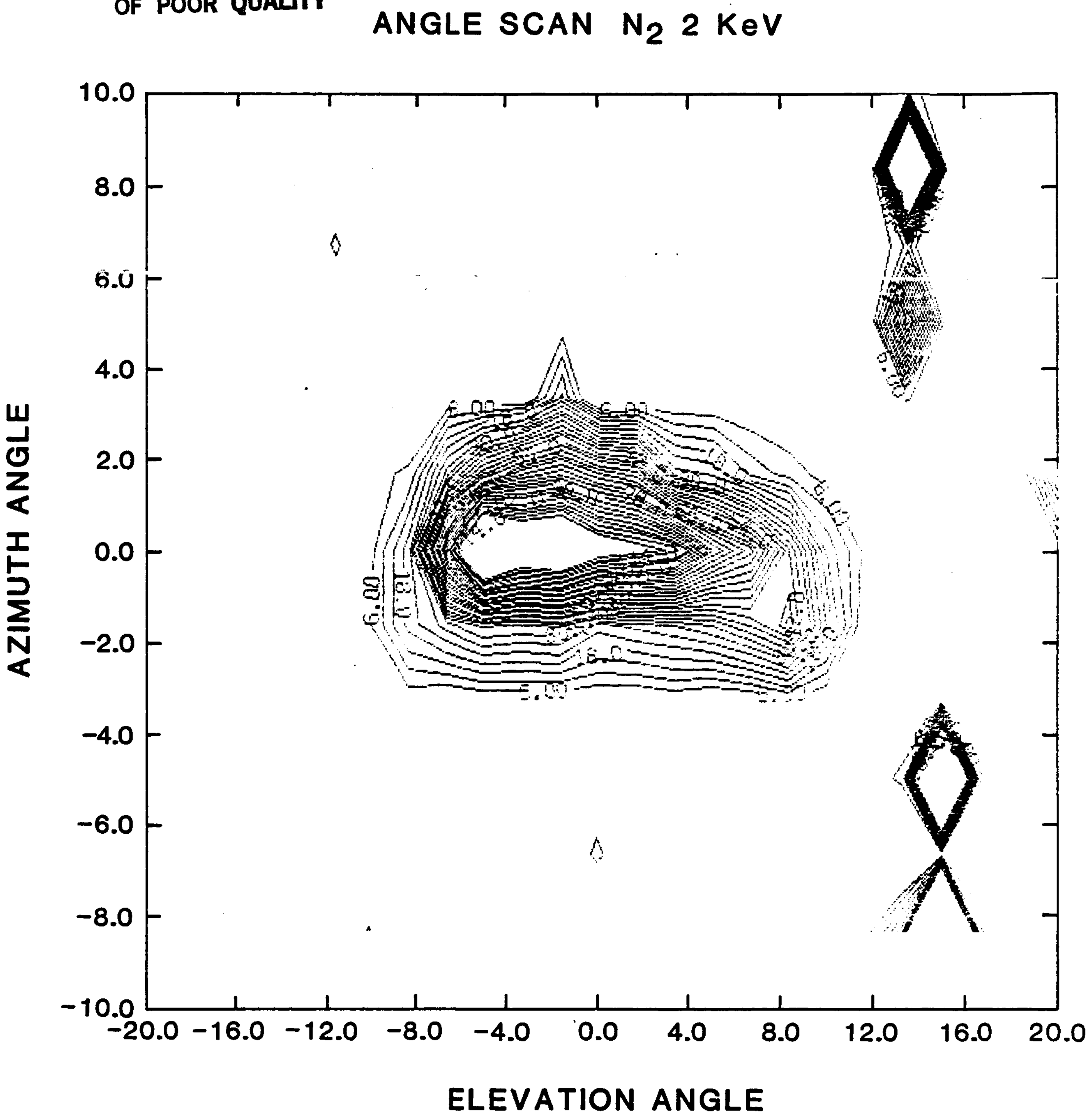
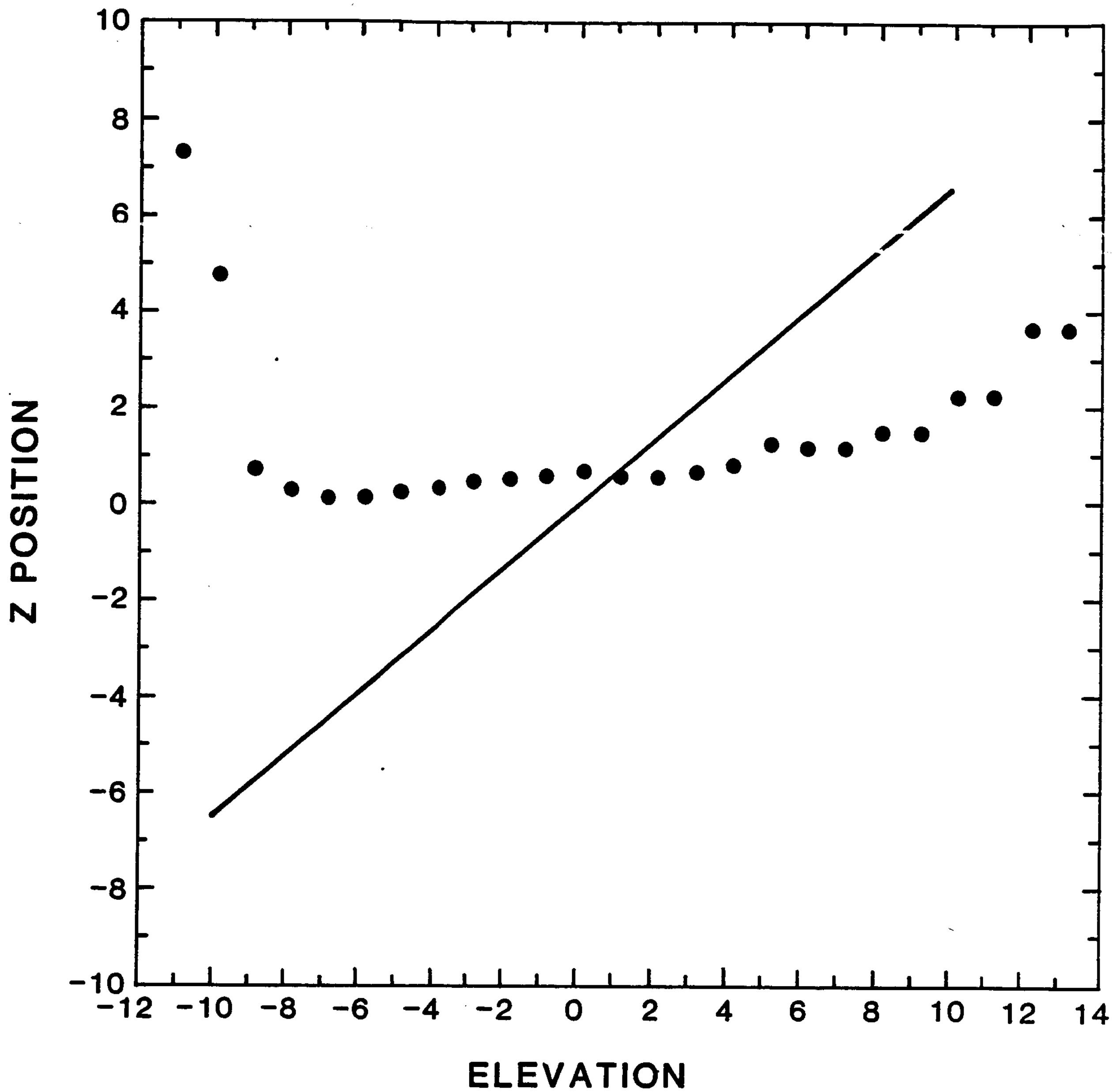


Figure 3-2b



10
8
6
4
2
0
-2
-4
-6
-8
-10
Z POSITION
-12
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
14
ELEVATION

Figure 3-3

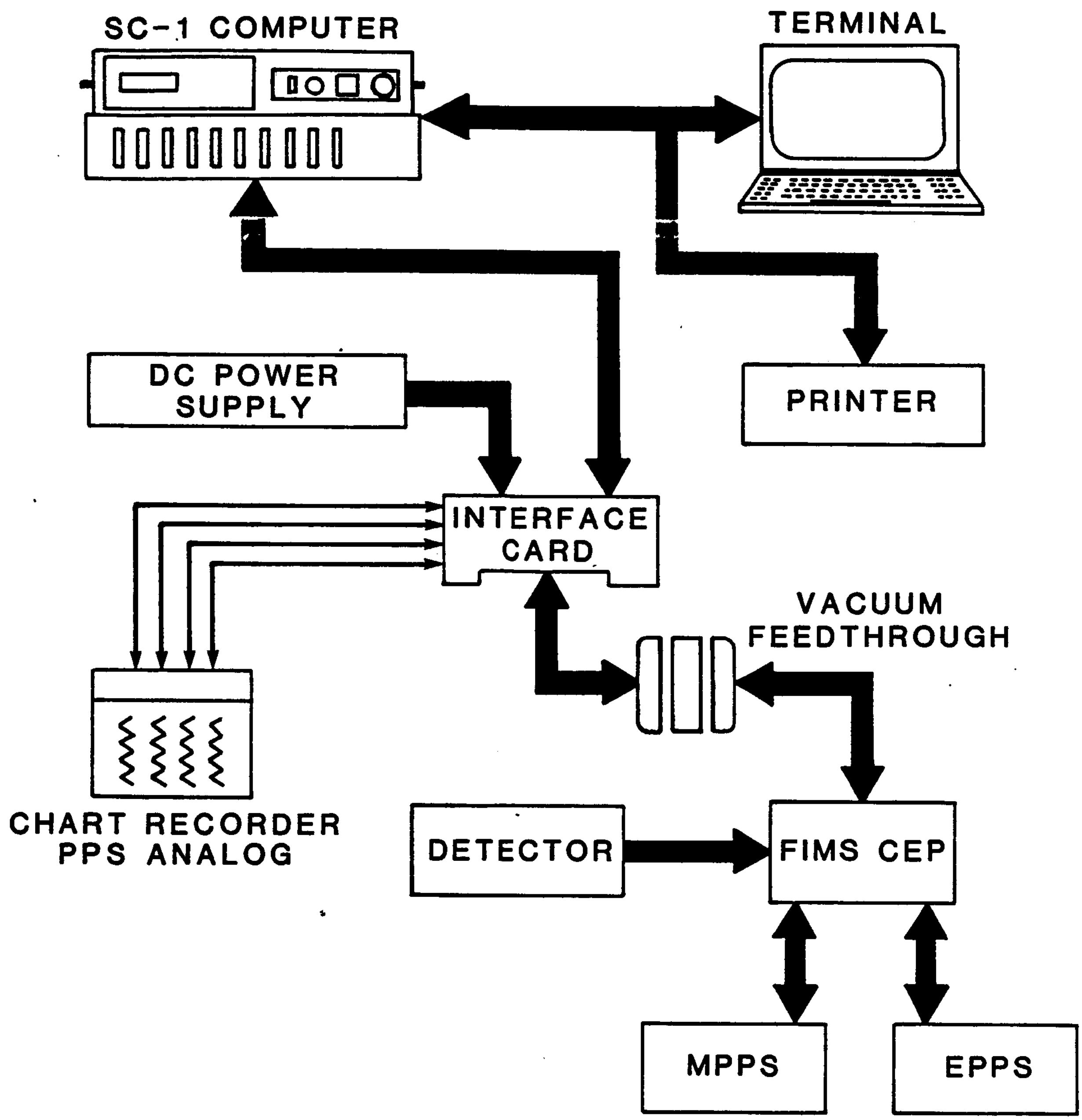

SC-1 COMPUTER
TERMINAL
DC POWER SUPPLY
PRINTER
INTERFACE CARD
VACUUM FEEDTHROUGH
CHART RECORDER PPS ANALOG
DETECTOR
FIMS CEP
MPPS
EPPS

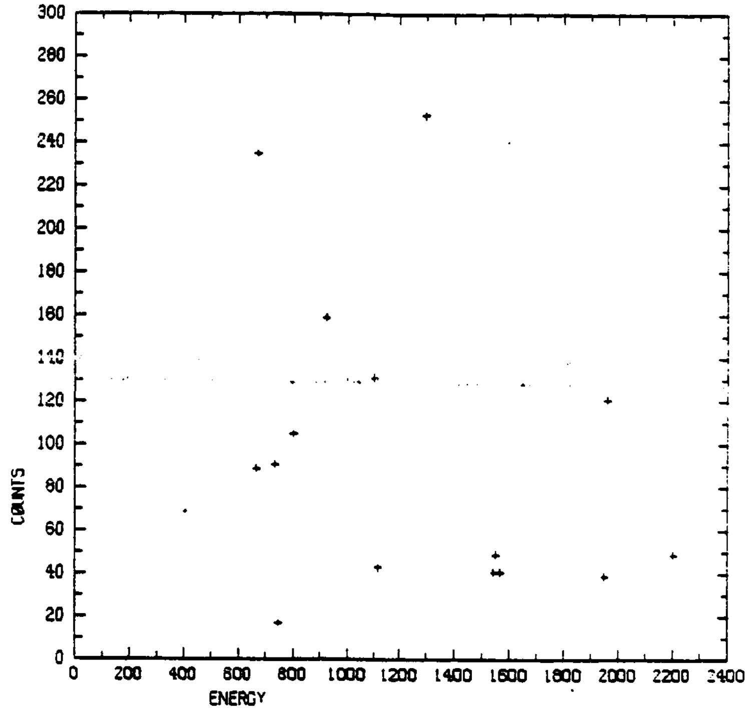
Figure 3-4

4. SCIENCE RESULTS

In January of 1986 the Centaur II sounding Rocket was launched from the Andoya Range in Norway. Due to a mechanical failure, the nose cone of the rocket was never completely released, blocking the view of the scientific payload and resulting in an inappropriate and shortened trajectory. Telemetry tapes recorded at the station in Andoya, and also by the NASA Wallops portable tacking station onsight, were studied extensively in the hope that some data might be retrieved; however, no clear evidence of mass peaks or a mass/energy correlation could be found.

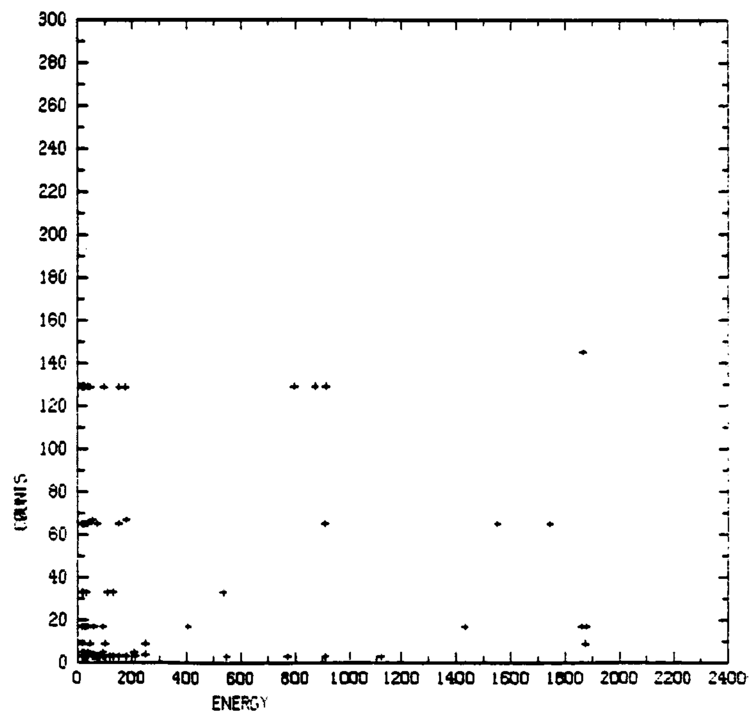
Figure 4-1 shows data from the original Andoya tapes; note the anomalous counts at powers of 2 (2, 4, 16, etc.). Figures 4-2 through 4-6 show data from the tapes supplied by Wallops. Figure 4-2 shows data from the first tape supplied by Wallops, selected for masses in the NO^+ range in (a) and the O^+ range in (b). Figure 4-3 shows the same data eliminating the time period in which the high voltage was turned on. Figure 4-4a shows data from the instrument inner channel and Figure 4-4b shows the same data eliminating the time interval for high-voltage turn-on. Figures 4-5a and 4-5b show data for the O^+ range and the NO^+ range, respectively, from the second Wallops tape. Finally, Figures 4-6a and 4-6b show data from the inner channel selected on the H_2^+, H_e^+ range and on the NO^+, O^+ range, respectively, from Wallops tape 2. Figure 4-6 clearly indicates that these counts are due to noise, since data are identical with the voltages set in the high-mass range (incorrect for the inner channel) and with voltages set in the low mass range (proper setting for this channel).

In summary, in all the outer channel data we see a noise pattern occurring at powers of two, and in all the inner channel data we see a constant (noise) count rate around 30-60 counts.



Masses Between 0 and 8.

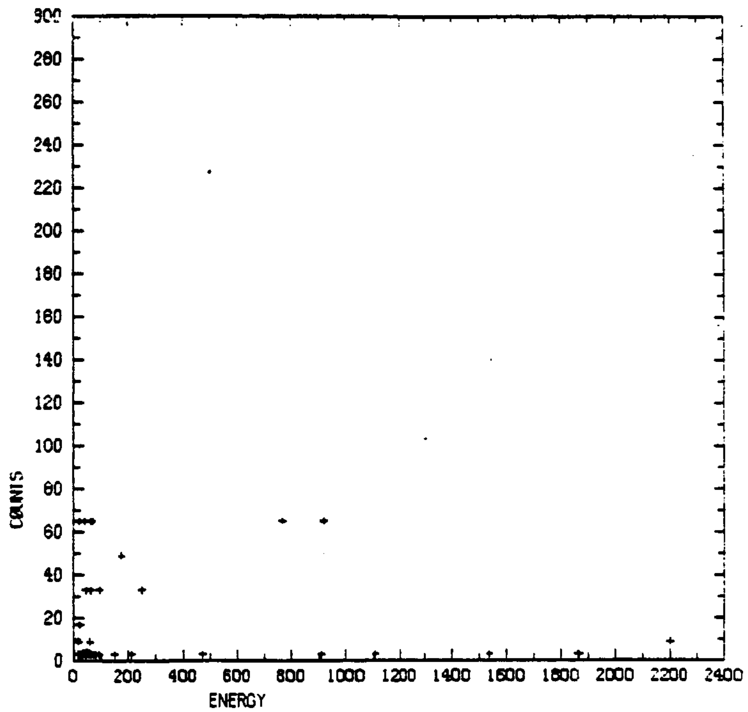
(a)



Masses Between 12 and 20.

(b)

Figure 4-1



Masses Between 20 and 40.

(c)

Figure 4-1

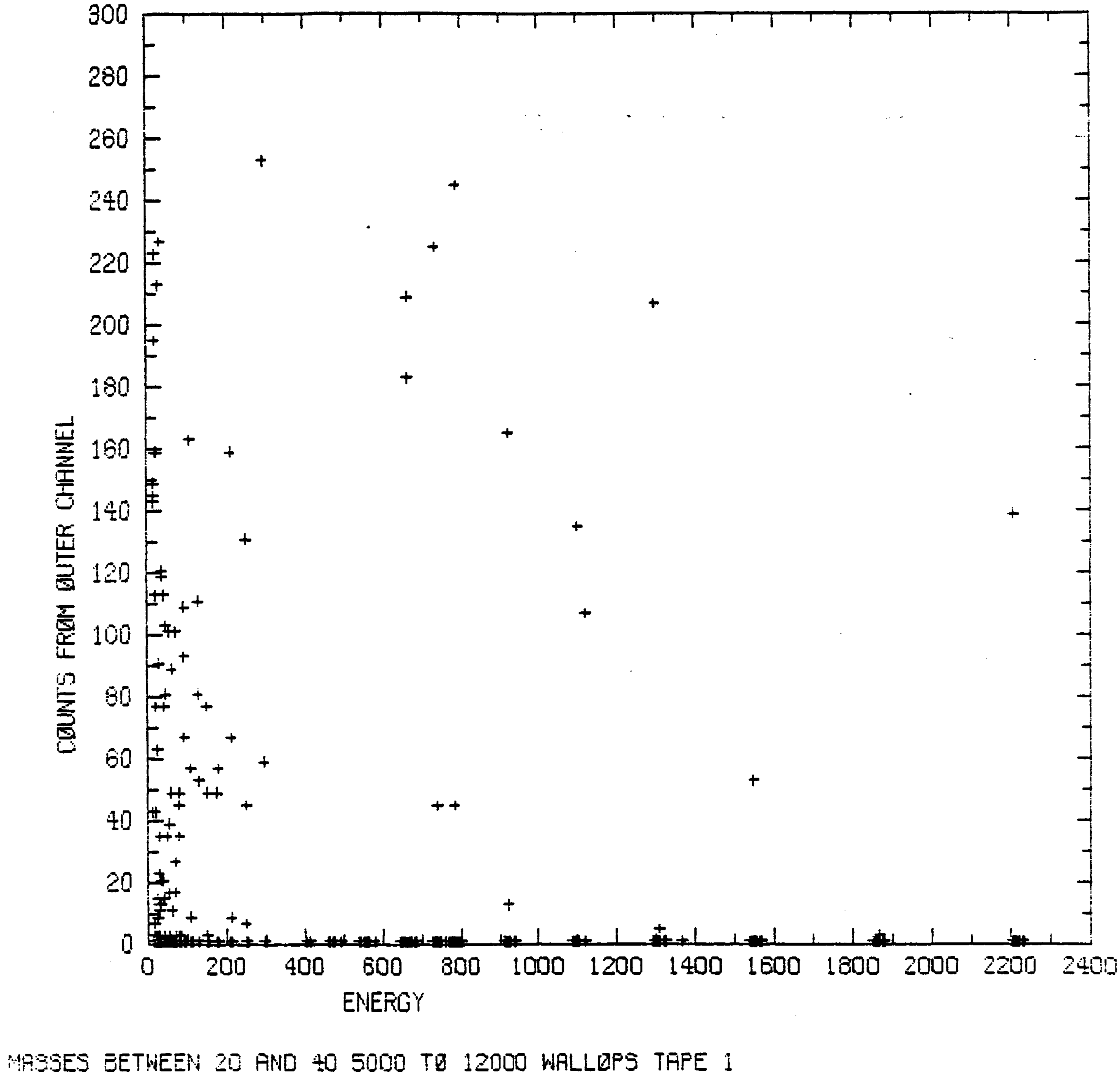

COUNTS FROM OUTER CHANNEL
ENERGY
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
MASSES BETWEEN 20 AND 40 5000 TO 12000 WALLOPS TAPE 1

Figure 4-2a

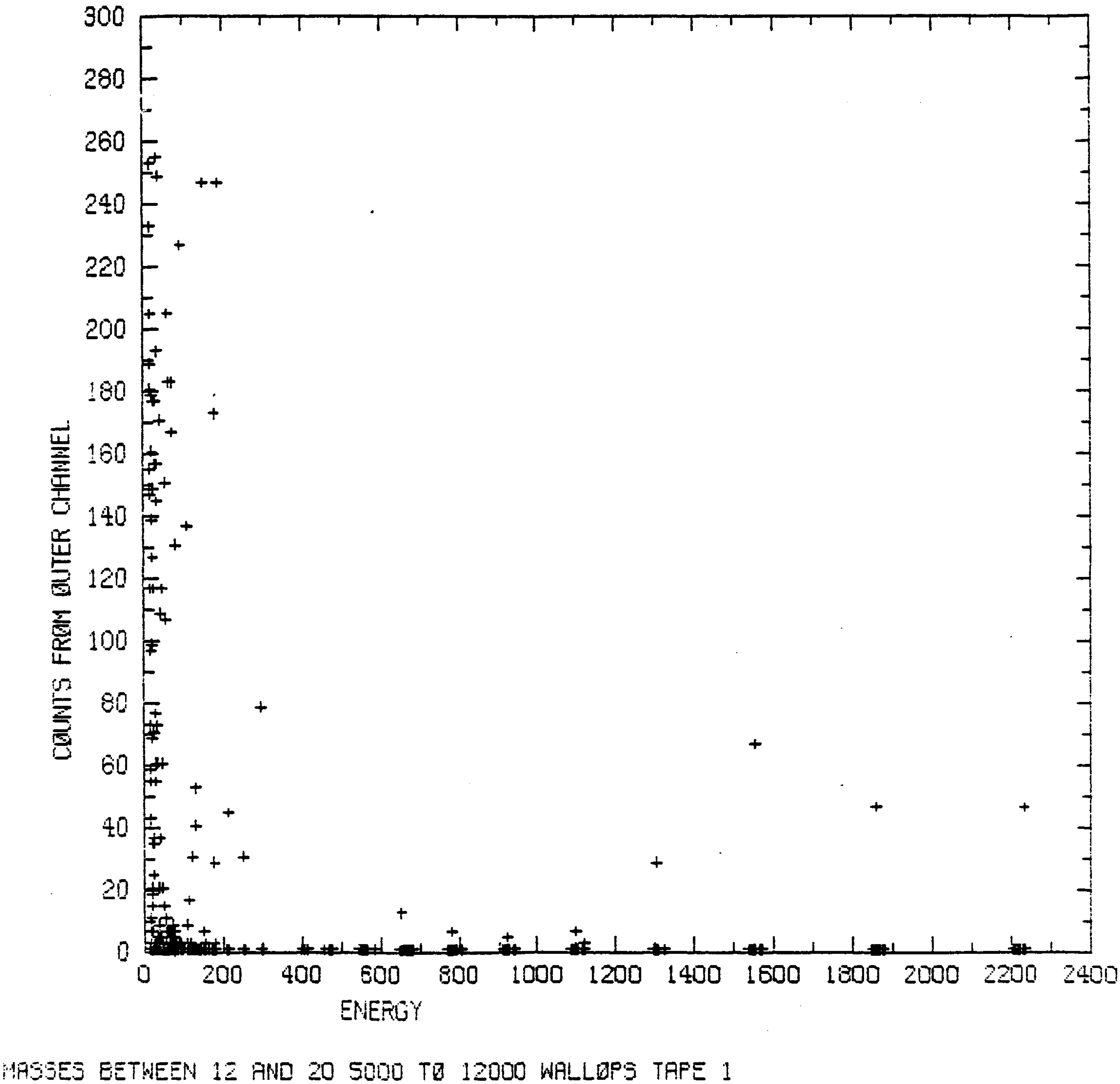

300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
COUNTS FROM ØUTER CHANNEL
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
ENERGY
MASSES BETWEEN 12 AND 20 5000 TØ 12000 WALLØPS TAPE 1

Figure 4-2b

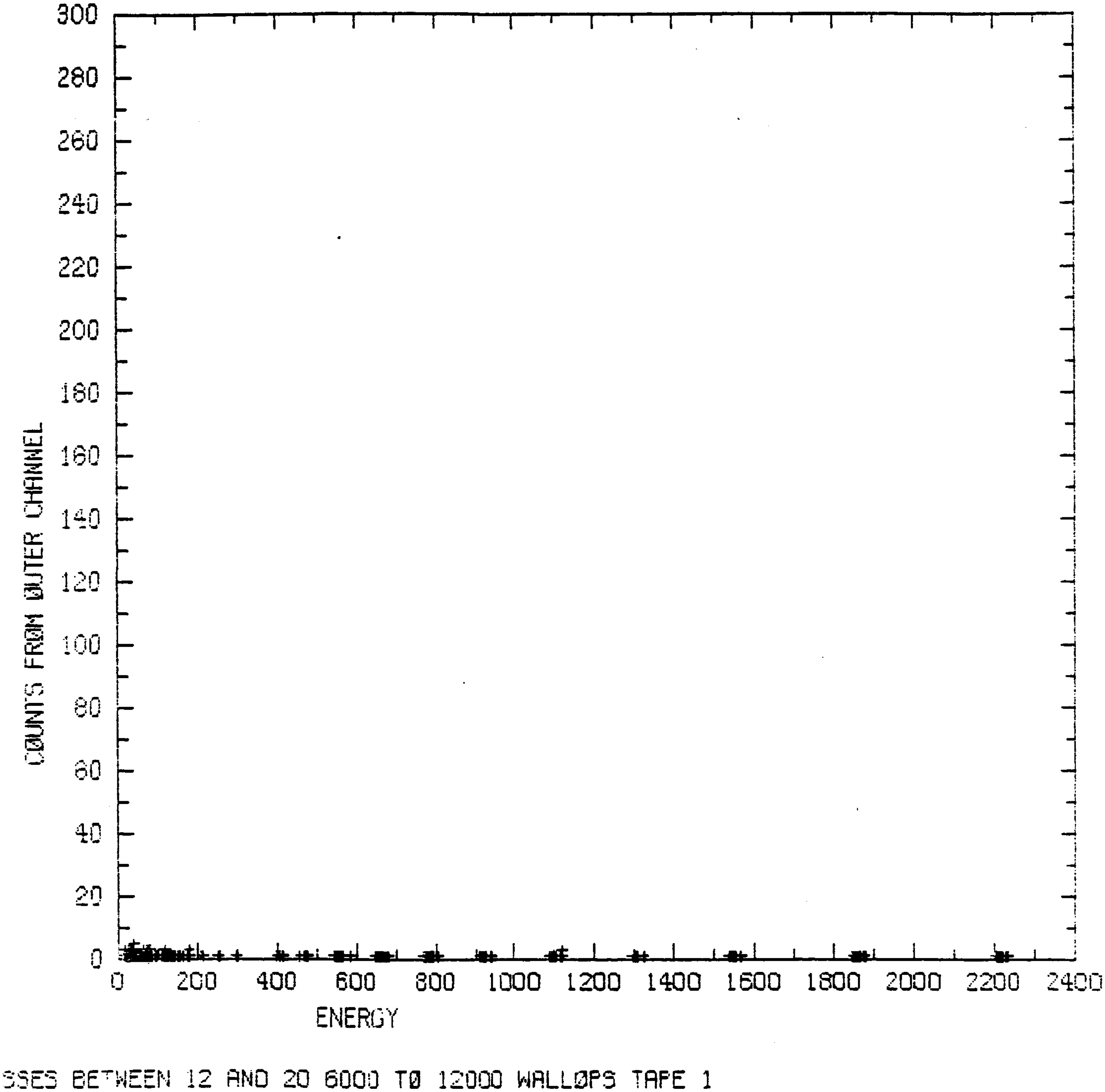
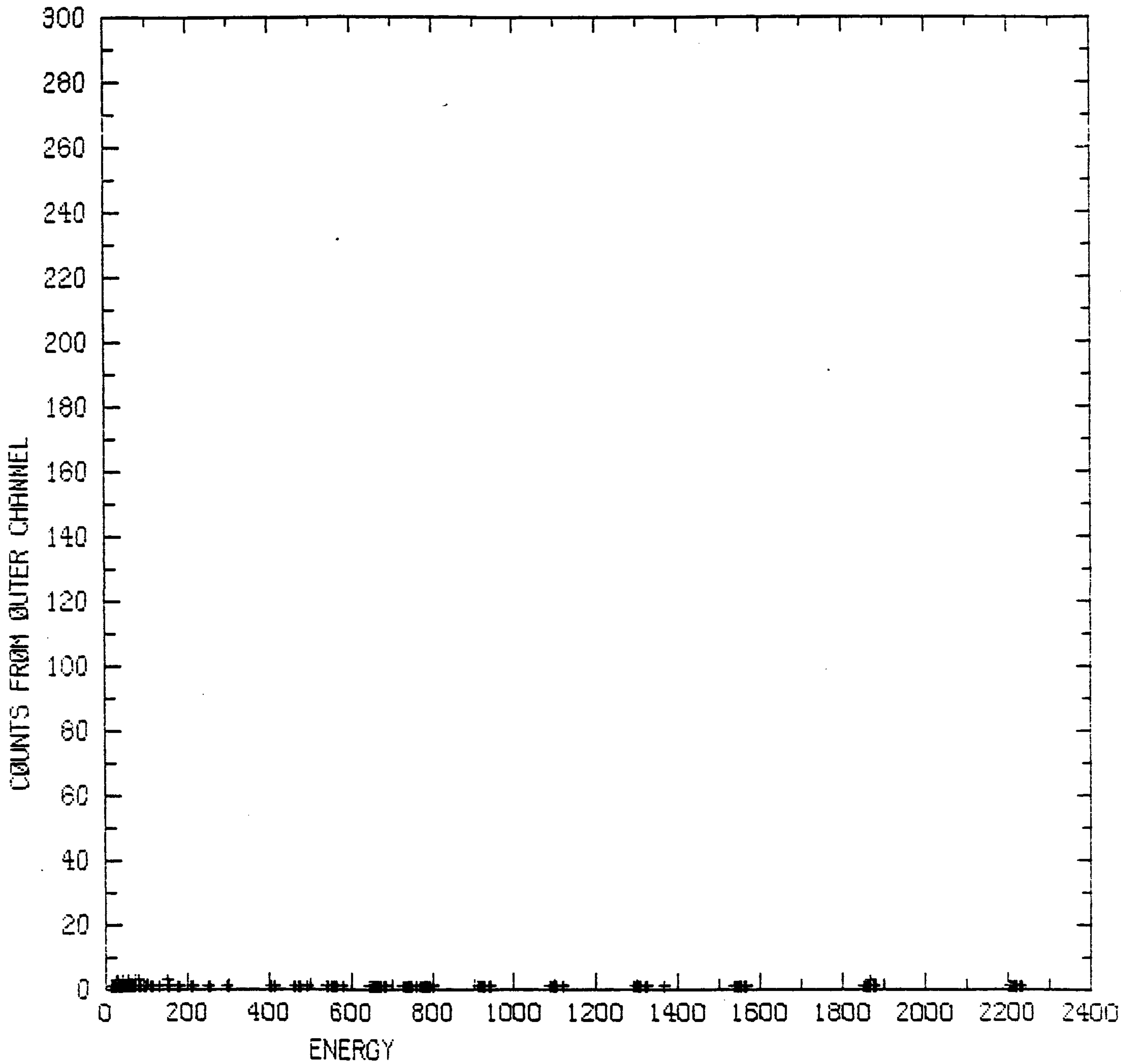
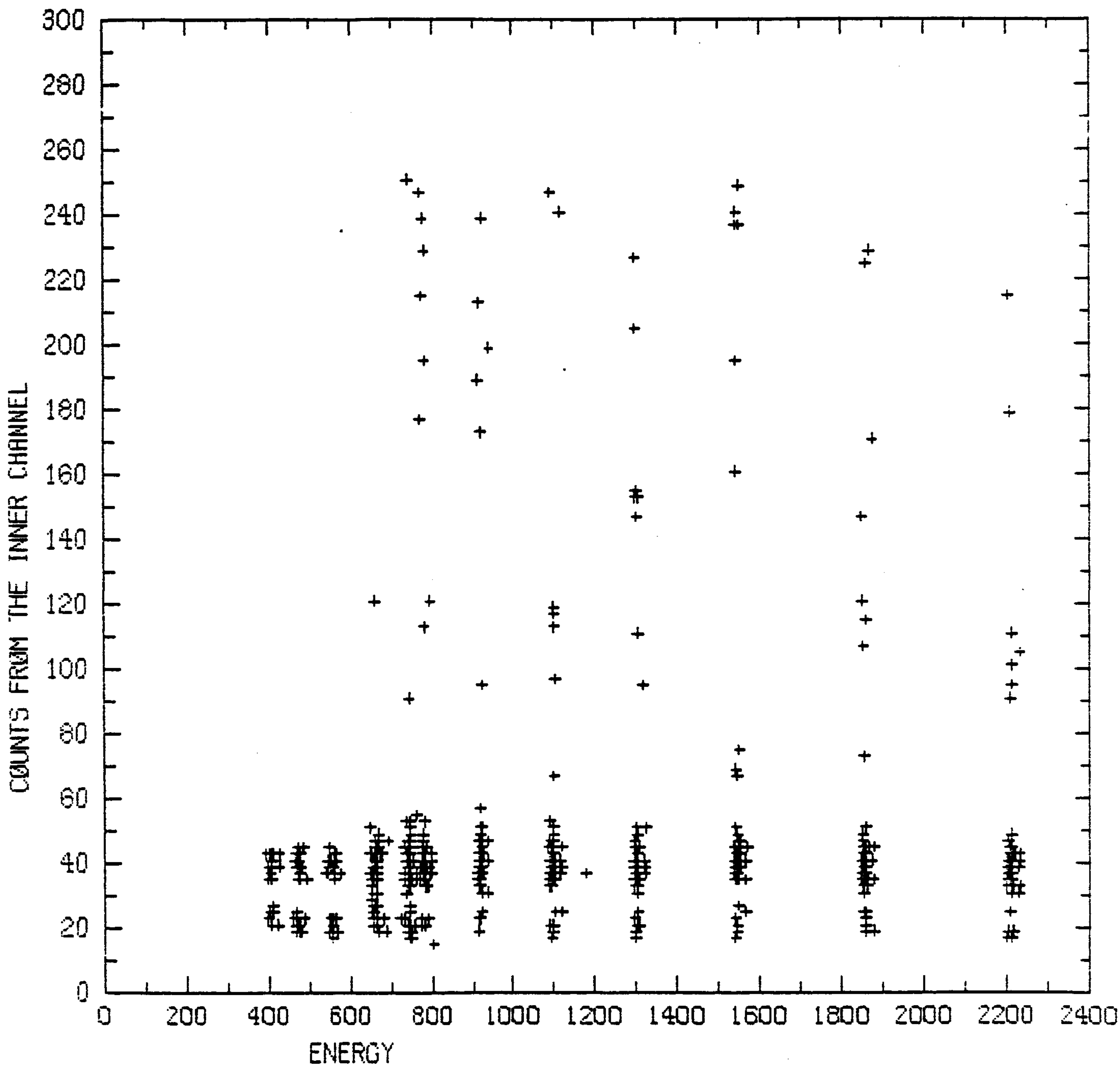

300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
COUNTS FROM ØUTER CHANNEL
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400
ENERGY
MASSES BETWEEN 12 AND 20 6000 TØ 12000 WALLØPS TAPE 1

Figure 4-3a



MASSES BETWEEN 20 AND 40 6000 TO 12000 WALLOPS TAPE 1

Figure 4-3b



WALLOPS TAPE 1 MASSES LESS THAN 10

Figure 4-4a

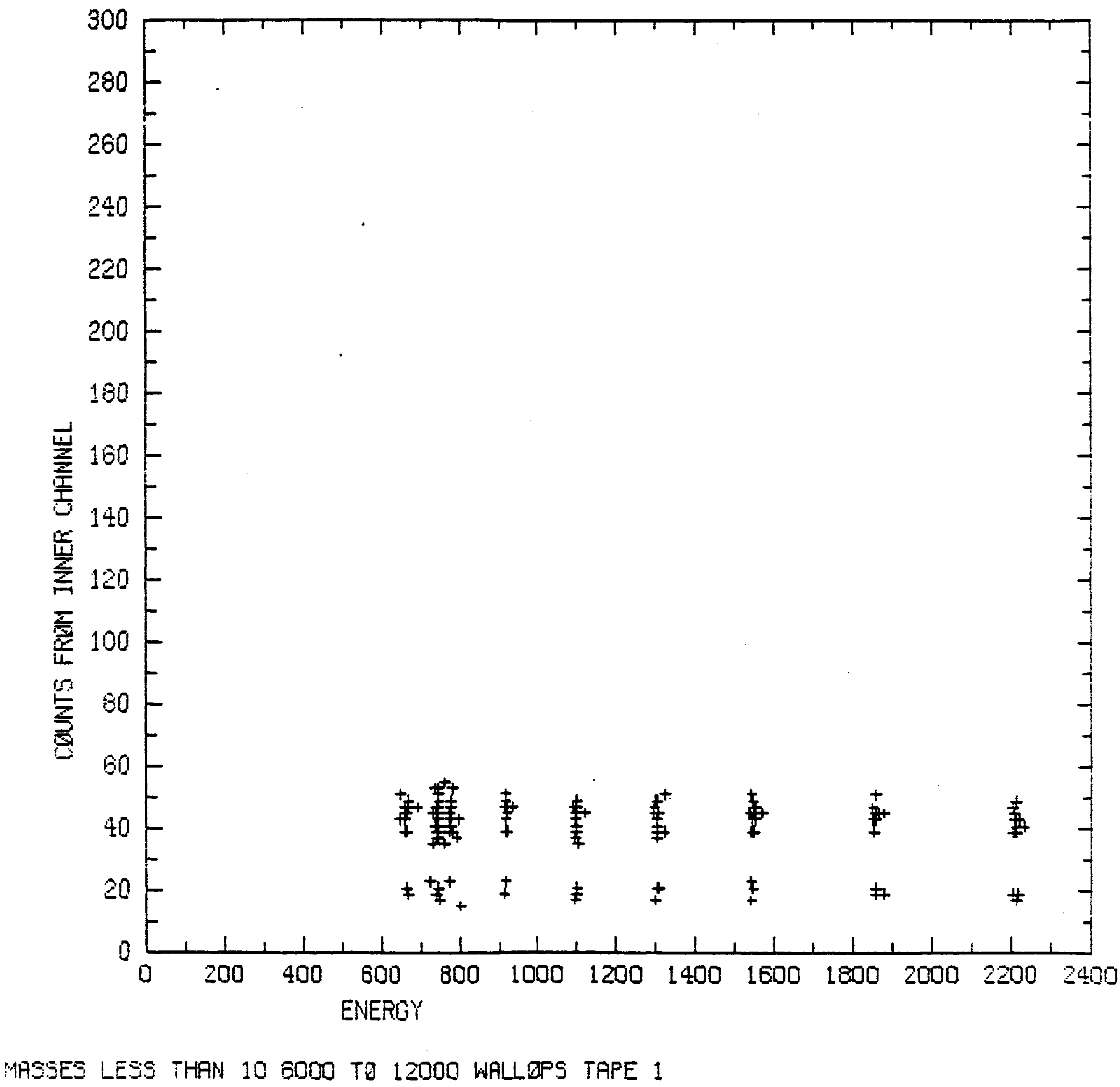

COUNTS FROM INNER CHANNEL
ENERGY
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
MASSES LESS THAN 10 6000 TØ 12000 WALLØPS TAPE 1

Figure 4-4b

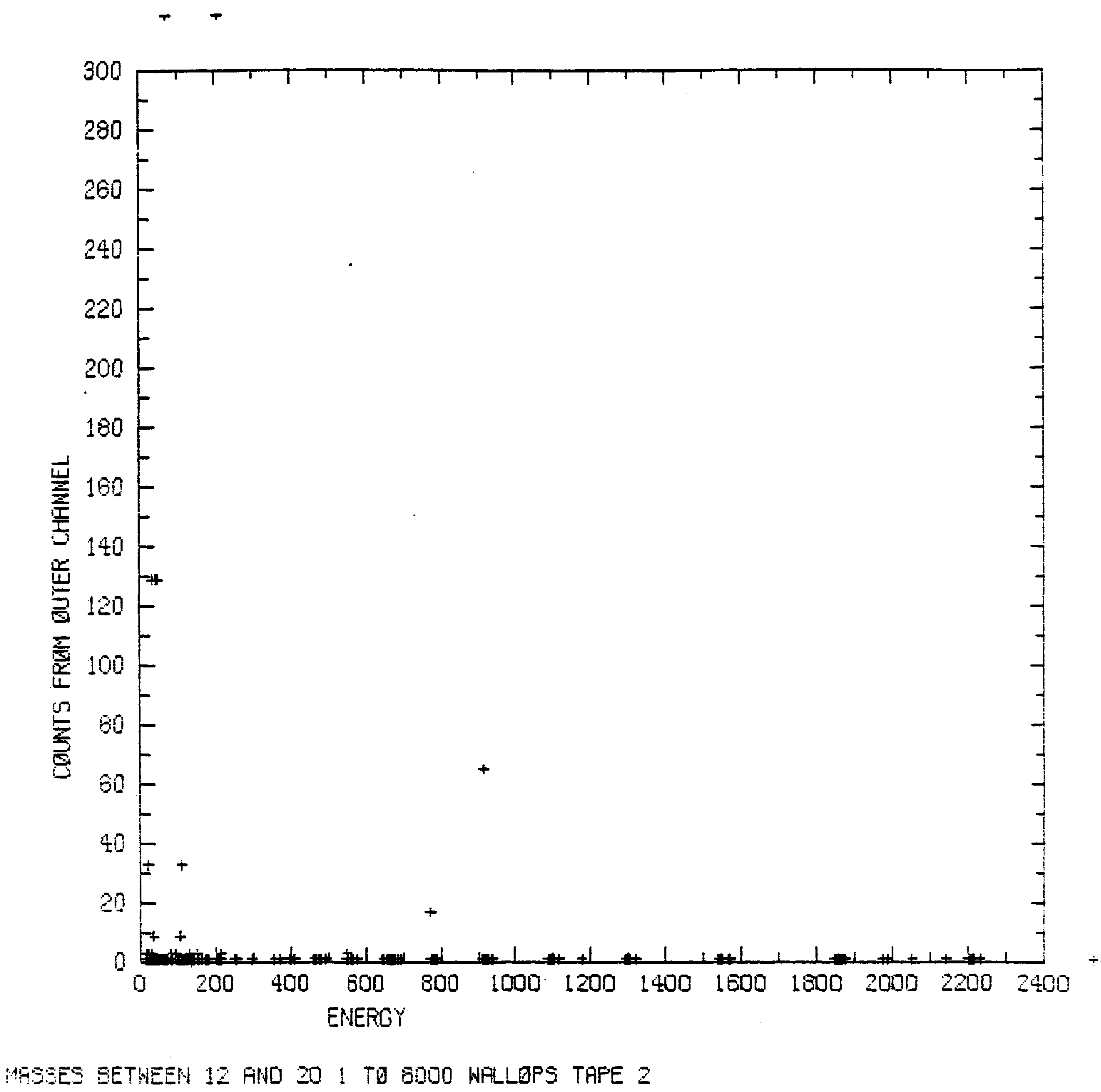

300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
COUNTS FROM OUTER CHANNEL
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
ENERGY
MASSES BETWEEN 12 AND 20 1 TO 8000 WALLOPS TAPE 2

Figure 4-5a

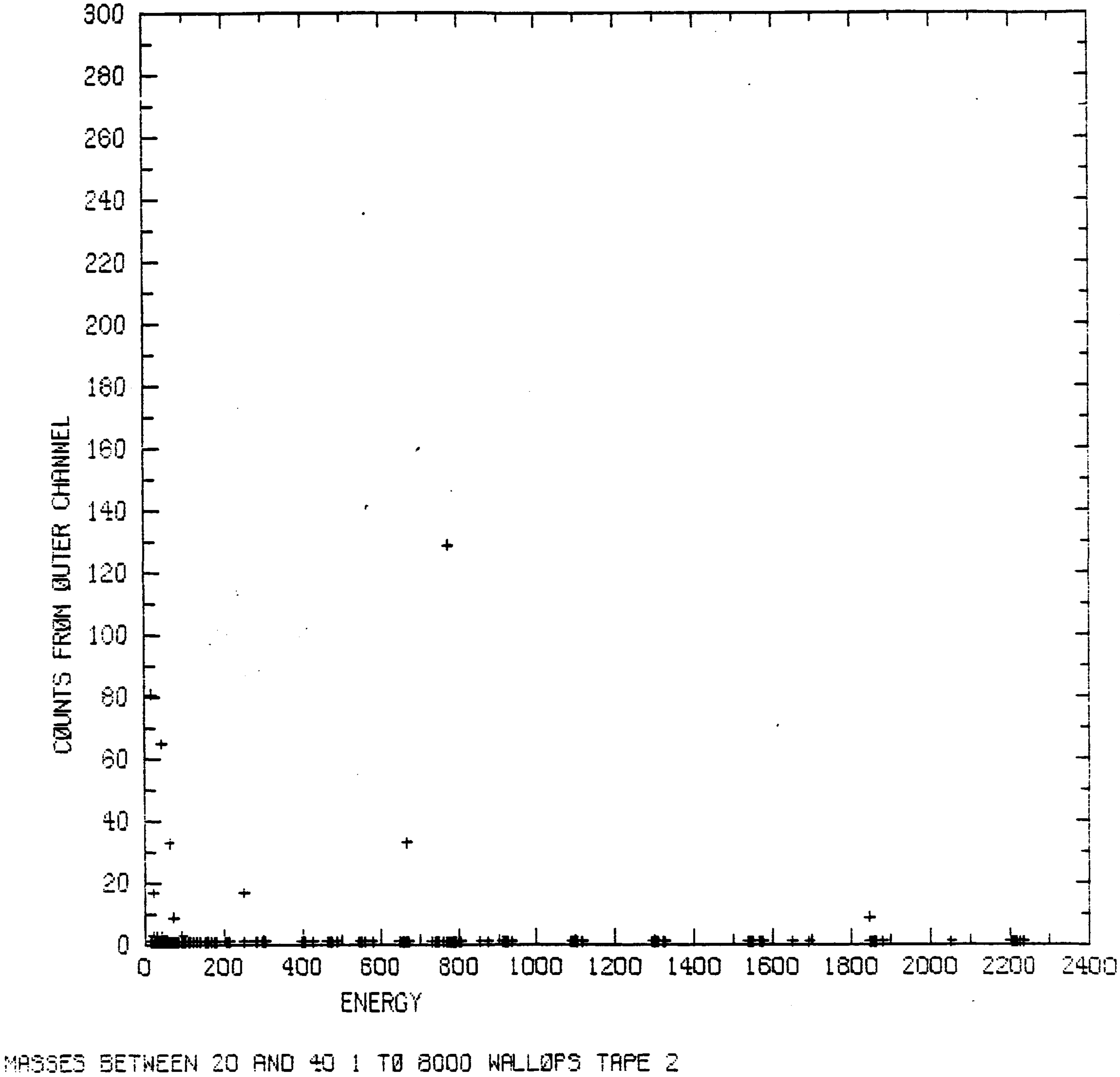
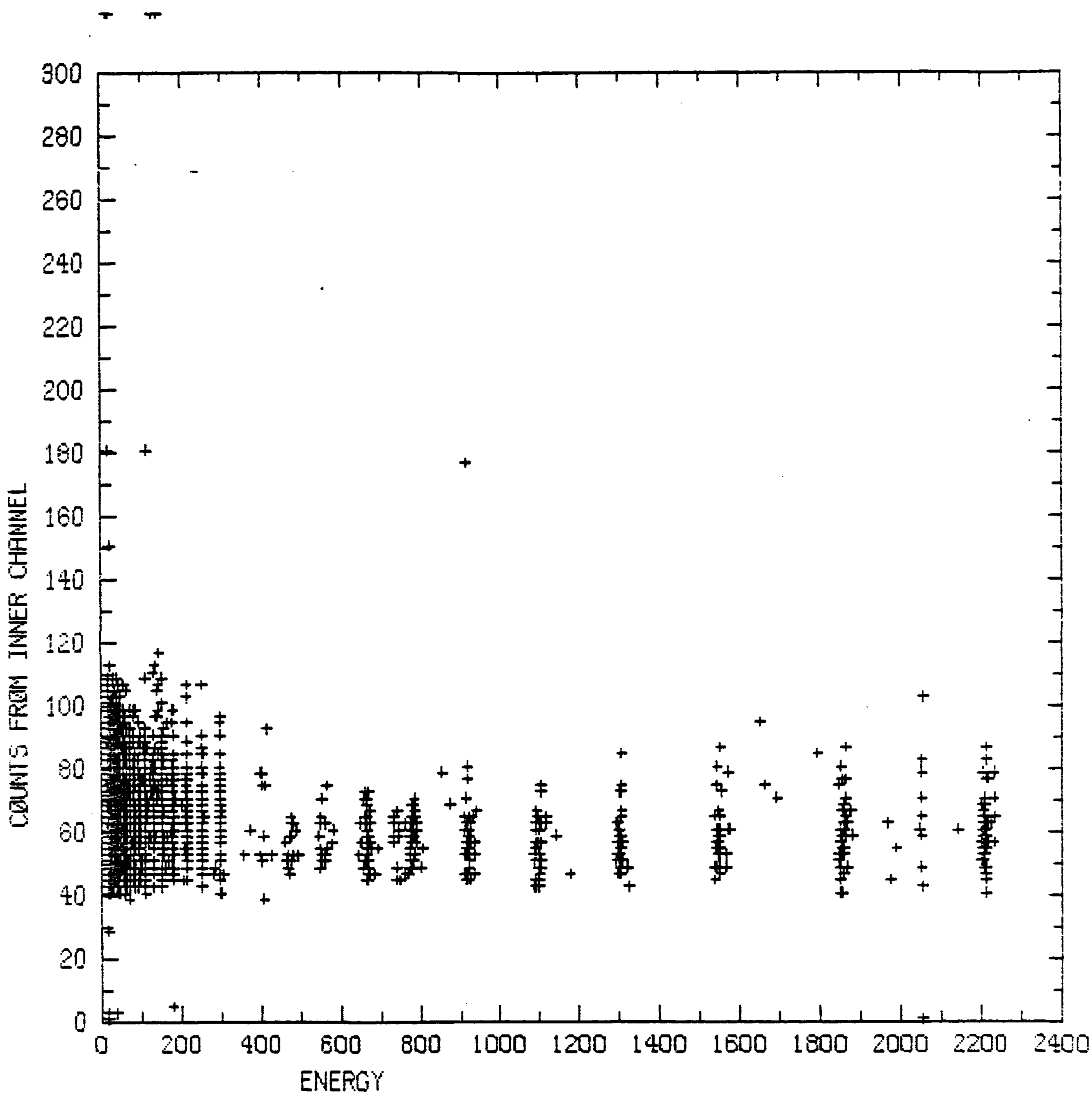
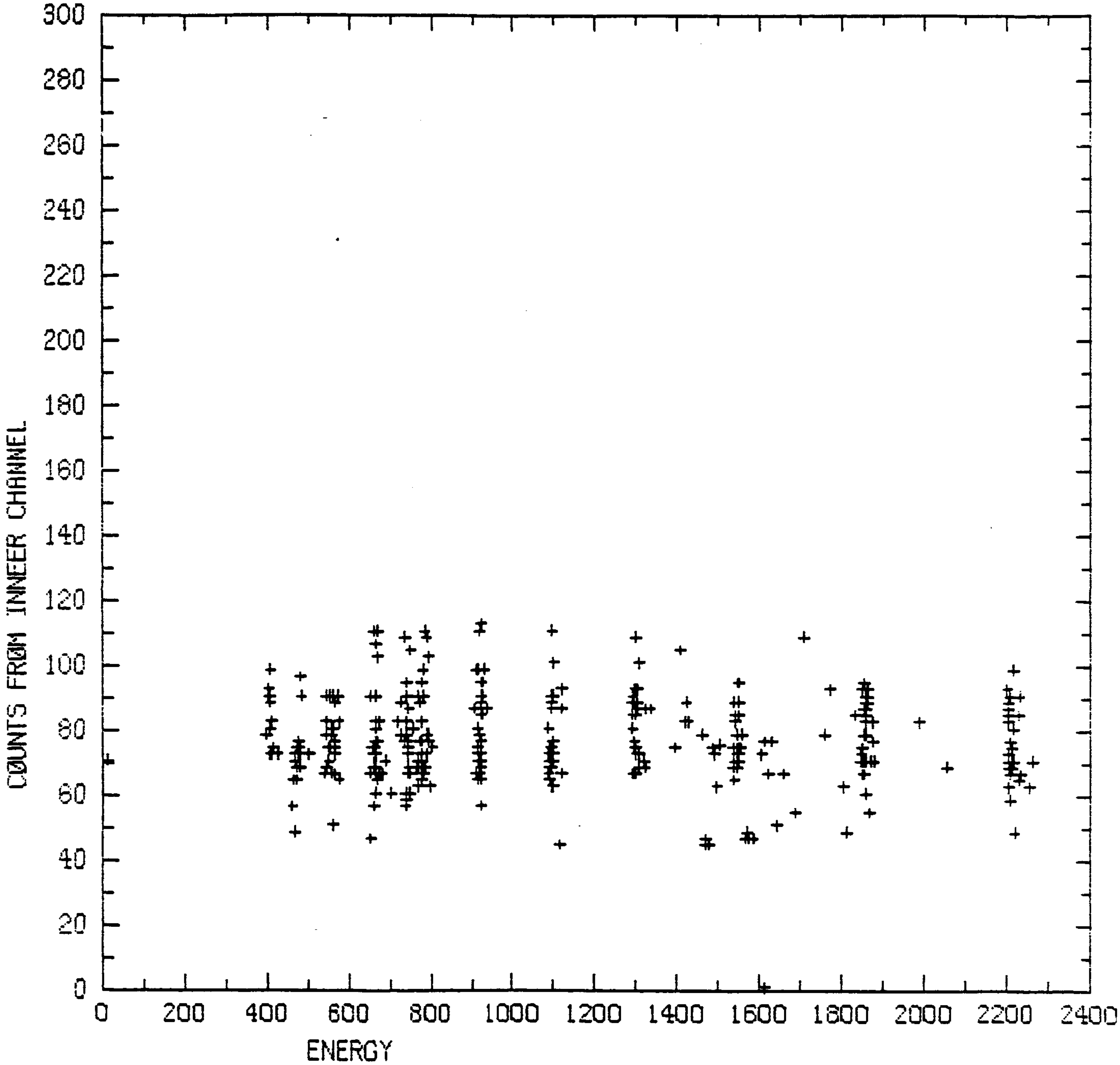

300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
COUNTS FROM OUTER CHANNEL
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400
ENERGY
MASSES BETWEEN 20 AND 40 1 TO 8000 WALLOPS TAPE 2

Figure 4-5b



MASSES BETWEEN 10 AND 40 WALLOPS TAPE 2

Figure 4-6a



MASSES LESS THAN 10 1 TO 8000 WALLOPS TAPE 2

Figure 4-6b

5. REFERENCES

Dusenbery, P.B. and Lyons L.R., "Generation of Ion-Conic Distribution by Upgoing Ionosperic Electrons", Journal of Geophysical Research, Vol.86, No.A9, pp. 7627-7638, September 1, 1981.

Klumpar, D.M., "Transversely Accelerated Ions: An Ionospheric Source of Hot Magnetosperic Ions", Journal of Geophysical Research, Vol.84, No. A8, pp. 4229-4237, August 1, 1979.

APPENDIX A

FIMS C Data Logbook

ASSEMBLY/COMPONENT NAME		SPEC. NO.	MSFC PART NUMBER		VENDOR PART NUMBER
		50M26270	40M26271		ER-65120
CALIBRATION ASSEMBLY	IR NO.	REV. B	REV. A	EO's 1,2,3	REV. C
TELEMETER - MODEL 2	RV-902	EO's 1,2	SER. NO. 060	EPL NO.	EPL 65120-100

SECTION 1 / IDENTIFICATION DATA

SUBASSEMBLY NAME	IR NO.	PART NO.	REV	S/N	EO'S	EPL NO.	DAR'S/MRD'S
CONTROL PANEL	AP-372	50M12347	A	006	NONE	-101B	AP-0096
POWER SUPPLY	BA-302	50M12368	C	004	1,2	-101	NONE
WIRING HARNESS	AZ-021	50M12396	NC	N/A	1	-101A	NONE
							5/20/71

SAMPLE
(ALL ENTRIES FICTIONAL)

identification data...

Section 1: (1) List assembly/component name, inspection report (IR) number, MSFC specification number with revision and EO's, MSFC vendor part number and revision, serial number and engineering parts list (EPL) number. (2) Information on subassemblies/major components that are serialized or time and cycle sensitive should be recorded when included as a part of the main assembly. (3) All data entered in this section should reflect the as-built configuration and shall not be updated. (Changes to the as-built configuration shall be recorded in Section 3, Life History.) (4) Quality will certify by stamping and dating the bottom right hand corner of the last page of Section 1 to signify that the identification data accurately reflects the as-built configuration of the article at the time of layout/build-up inspection.

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section 1

ALLOWABLE OPERATING TIME/CYCLES	1200 hours
CALENDAR LIFE	1 years

SECTION 2 / SPECIAL INSTRUCTIONS

DATE	Instructions/Storage Time/Environmental Levels/Cleanliness/Handling/Flight Disqualification
2/01/71	Record the following variables data in Section 4 during post manufacturing checkout:
	1. Calibration cycle time per paragraph 3.3.4c of Specification 50M26270B.
	2. Frequency check per paragraph 3.3.6d of Drawing 50M26270B.
2/01/71	Electrical circuitry contains polarity sensitive items. Reference Note 7 of Drawing 40M26271A.
2/01/71	Record all unit "Power" On" time in hours/minutes in Section 3.
2/01/71	Record cycles on relay P/N 50M12370 in Section 3.
	1. Energizing and denergizing the component constitutes one cycle.
	SAMPLE (ALL ENTRIES FICTIONAL)

Special Instructions:

Section 2: (1) List special safety precautions required to prevent death or injury to personnel and/or damage to the hardware. (2) List special retest, replacement, and service requirements. (3) Factors which would disqualify a component for flight or restrict its use should be listed here. Factors to be considered should include limiting aspects of environmental exposure, etc. (4) Design Engineering will specify the parameters that define a cycle. (5) Any other special instructions of any nature should be entered here.

section 2

SECTION 3 / LIFE HISTORY

ORGANIZATION / LOCATION	EVENT NO.	EVENT SUBJECT	DATE	SUMMARY OF CHRONOLOGICAL EVENTS TEST DOC NO/TEST DESC/NATURE & DESC OF MALFUNCTIONS/SER NO OF REMOVED OR REPLACED PARTS/MODS/ADJUST/REPAIRS/MAINT/SHIPPED/REC'D/ENVIRON/ETC.	RUNNING TIME/CYS HOURS & MINUTES/~ START	STOP	TOTAL TIME/CYS	CUM TOTAL	STAMP OR INITIALS
PROD RM CO.	1	Run-in	6-10-71	POST MANUFACTURING RUN-IN TEST PER SPEC. RM-869	09:40	09:50	00:10	00:10	JD
QUAL. RM CO.	2	Accep. Test	6-11-71	ACCEPTANCE FUNCTIONAL TEST PER RM-870 SWITCH S3 FAILED OPEN. REF. DR 01266.	08:00	09:58	01:58	02:08	08
PROD. RM CO.	3	Rework	6-11-71	REPLACED TOGGLE SWITCH S3 P/N 207842 ON CONTROL PANEL (REF. WO 8050)	--	--	--	02:08	RJ
QUAL. RM CO.	4	Accep. Test	6-12-71	ACCEPTANCE FUNCTIONAL TEST PER RM 870.	08:00	12:20	04:20	06:28	08
PROD. PM CO.	5	Final Cleaning	6-15-71	CLEANED AND PACKAGED PER SPECIFICATION RM 810.	--	--	--	06:28	RB
QUAL. RM CO.	6	Ship	6-16-71	SHIP TO MSFC (Ref. SO-1110)	--	--	--	06:28	08
QUAL-AFR Bldg. 4752	7	Receiving Inspection	6-29-71	VISUAL AND DIMENSIONAL	--	--	--	06:28	[illegible]
QUAL-AFT Bldg. 4708	8	A.C.E. Functional	7-6-71	ACCEPTANCE FUNCTIONAL TEST PER ATP 40M38571-A	10:00	12:00	02:00	08:28	[illegible]
QUAL-AF Bldg. 4705	9	Transfer	7-10-71	ROUTED TO S&E-PE FOR STORAGE.	--	--	--	08:28	[illegible]
PE-PMC Bldg. 4705	10	Storage	7-10-71	RECEIVED AT SR-~~06~~ 10 SC 7/10/71	--	--	--	08:28	A.C
PE-PMC Bldg. 4705	11	Assignment	8/1/71	WITHDRAWN FROM STORAGE ON W.O. 71G-8571 ROUTED TO BLDG. 4708.	--	--	--	08:28	AG
PE-RM Bldg. 4708	12	Installation	8/8/71	INSTALLED ON 50M10015 UNIT S/N 008 PER TPS-ATM-FLT-0431	--	--	--	08:28	OD
QUAL-PC Bldg. 4708	13	Check-out	8/14/71	POST MANUFACTURING CHECKOUT PER FLT-TCP-H-70009	09:15	15:20	06:05	14:28	[illegible]

SAMPLE
(ALL ENTRIES FICTIONAL)

Life History:

Section 3: (1) The MSFC organization building number or sub-contractor facility conducting test will be entered in the "Location/Organization" block. (2) Identification of separate and distinct events will be entered in the "Event" block by number, subject, and date. Subjects should include but not be limited to: inspection, test, maintenance, repairs, shipment, etc. (3) Complete item history will be included in the "Summary of Chronological Events" using as a guide applicable events listed in the heading. (4) The Start and Stop time shall be recorded when required. The difference between stop and start times shall be added to the previous cumulative total to give the new total. If there are mechanical operations or cycle effects not proportional to the on-off, or total running time of the component, then these mechanical operations and cycles should be tallied along with the run time entries. (5) There shall be a stamp or initials entered for each completed event. (6) Enter the NR Number in the "Summary of Chronological Events" column when an item is rejected.

section 3

SECTION 3 / LIFE HISTORY

ORGANIZATION LOCATION	EVENT NO.	EVENT SUBJECT	DATE	SUMMARY OF CHRONOLOGICAL EVENTS TEST DOCUMENT NO./TEST DESCRIPTION/NATURE & DESCRIPTION OF MALFUNCTIONS/SERIAL NO. OF REMOVED OR REPLACED PARTS/ MODIFICATIONS/ ADJUSTMENTS/REPAIRS/MAINTENANCE/SHIPPED/REC'D/ENVIRON./ETC.	RUNNING TIME/CYCLES HOURS AND MINUTES/~ START	STOP	TOTAL TIME/CYS	CUM TOTAL	STAMP OR INITIALS
BLDG. 68 F-3		FIMS CEP	28/JUNE	INSTALLATION OF CPU BOARD IN CEP CHASSIS L.V. POWER ON TEST. 1.15mA @ 5Vdc.					
BLDG. 68 D-3		FIMS CEP	17/SEPT	COMPLETION OF CEP BOARD TROUBLE SHOOTING —COMMENCE FLIGHT SOFTWARE					
BLDG 68 E-5		FIMS CEP	17/SEPT	CEP CARD EDGE CONNECTORS WIRING VERIFIED					
SwRI E-5		CAL	30DEC85	FIRST ATTEMPT AT CAL - GAIN TOO LOW, RAISED R-Y X2. TOO NOISY - ATTEMPT LOST.					DCG
SwRI E-5		CAL	31DEC	2ND ATTEMPT AT CAL - GAIN RESISTORS CHANGED BACK TO 100Ω.					WCG.
SwRI [illegible]		CAL	2 JAN	NEW VALUE RESISTOR ALLOWED GOOD DETECTION WITH LOW NOISE LEVEL.					[illegible]
[illegible]		[illegible] TEST	[illegible] JAN	[illegible] TEST COMPLETED. [illegible] BY [illegible]					[illegible]
[illegible] A		FINAL GSE [illegible]	13 JAN	[illegible] INPUT CALIBRATE [illegible] COMPLETE.					[illegible]
ANL [illegible]		[illegible] TEST	15 JAN	[illegible]					[illegible]

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SECTION 3 / LIFE HISTORY

ORGANIZATION / LOCATION	EVENT NO.	EVENT SUBJECT	DATE	SUMMARY OF CHRONOLOGICAL EVENTS (TEST DOCUMENT NO. / TEST DESCRIPTION / NATURE & DESCRIPTION OF MALFUNCTIONS / SERIAL NO. OF REMOVED OR REPLACED PARTS / MODIFICATIONS / ADJUSTMENTS / REPAIRS / MAINTENANCE / SHIPPED / REC'D / ENVIRON. / ETC.)	RUNNING TIME/CYCLES HOURS AND MINUTES/~ START	STOP	TOTAL TIME/CYS	CUM TOTAL	STAMP OR INITIALS
ANDOYA TEST RANGE		HORIZ. TAIL TEST	1-14-86	PRELIM TEST. CFP ONLY NO PPS SUPPLY. MONITOR 5-8, 9 & 16 ONLY	14:00				[illegible]
		VERT RAIL TEST [illegible]	1-14-86	PRELIM TEST CFP ONLY. NO PPS SUPPLY MONITOR 5-8, 9, 16 ONLY					[illegible]
ANDOYA TEST RANGE		LAUNCH 18:14 GMT	1-18-86	TCM LOST AFTER ≈ 125 SEC. H.V. SWITCHED ON @ 120 SEC.					
				MONITOR INDICATED THE BEGINNING OF COUNTING ACTIVITY, DATA MAY BE RETRIVED FROM TM / EM DATA.					

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			SECTION 4 / TEST DATA			
DESCRIPTION OF TEST	TEST PROCEDURE NO.	REV	TEST LIMITS	TEST RESULTS	DATE	STAMP OR INITIALS
Post Manufacturing Run-In	RM-869	—	Operate fro 10 Minutes	Satisfactory	6/10/71	J.D.
Acceptance Functional	RM-870	A	Reference Procedure	S3 Switch Failure	6/11/71	Q8
Acceptance Functional	RM-870	A	Reference Procedure	Satisfactory	6/12/71	Q8
Acceptance Functional	ATP 40M38571	A	Reference Procedure	Satisfactory	7/8/71	
Post Manufacturing Checkout	FLT-TCP-H-70009	—	Reference Procedure	Satisfactory	8/14/71	
a. Calibration Cycle Time Paragraph VI.C.1 d.			700 ± 35 Milliseconds	703 Milliseconds		
b. Frequency Check Paragraph VI.C.1 g.			1700 ± 51 Hertz	1694 Hertz		

SAMPLE
(ALL ENTRIES FICTIONAL)

section 4

Test Data:

Section 4: (1) The variable test data required to be recorded will be specified by Design Engineering in S Section 2. (2) Under "Description of Test" enter test procedure title or step and identification of the parameter being tested. (3) Identify the test procedure by number and revision level in the appropriate block. (4) Under "Test Limits" indicate the measurement limits for the test being conducted. (5) Under "Test Results" record the actual test measurement or satisfactory/unsatisfactory. (6) The test conductor's initials shall be noted in the column provided. (7) Normally, when tests are performed, detailed description of test, limits and results need not be recorded herein. Reference to the test procedure and data should be adequate, i.e., "Test performed in accordance with FLT-TCP-H-70009".
(8) The wire list E.O. level which is used to test electrical assemblies shall be recorded under description of test if applicable.

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PREFERRED FIMS DATA RECORDER FORMAT

CHAN 1	CHAN 2	CHAN 3	CHAN 4	CHAN 5	CHAN 6	CHAN 7	CHAN 7
S 10	A 41	A 42	S 8	S 9	A 43	A 44	A 47
FIMS MASS PPS STEP DATA	FIMS MASS PPS +V MONITOR	FIMS MASS PPS −V MONITOR	FIMS DATA	FIMS ~~MASS~~ ENERGY PPS STEP DATA	FIMS ENERGY PPS +V MONITOR	FIMS ENERGY PPS −V MONITOR	FIMS ±5 V MONITOR

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DATE/COMPONENT/EVENT	DESCRIPTION
28 JUNE 1985 CEP - CPU CARD ONLY LOW VOLTAGE APPLIED.	SUPPLYING 5V + RTN TO J5 OF CEP (PINS 5+6) MONITORED CURRENT WITH HP CLIP-ON DC MILLIAMETER NOTICE A PECULIAR POWER-ON CURRENT, SURGING ABOVE 200mA AND SETTLING TO 1.15mA OVER A 45sec PERIOD.
" "	MONITORING 5V LINES WITH SCOPE SEE QUITE A BIT OF NOISE WITH SCOPE (1Vpp RIPPLE) ON 5V BUS CLOSEST TO 82C84/B CLOCK GENERATOR CHIP. 5V LINE NEAR CONNECTOR IS PRETTY CLEAN
28 JUNE CEP + CPU + MEMORY CARDS LOW VOLTAGE APPLIED	240 mA @ 5V HALF A VOLT RIPPLE ON 5V BUSS (SCOPE)
5 AUG. 85 POWER APPLIED TO CPU + MEMORY CPU REMOVED TO ALLOW ICE PLUG-IN	240mA @5V NO READY LINE - NO RAM READ/WRITE GREIVOUS NOISE PROBLEM ON 5V LINE OF CPU CARD 82PC08 DEVICES WAY OVER HEATED - PRESUMED DEAD
11 SEPT. 85 POWER APPLIED TO CPU, MEMORY, + DETECTOR I/F. CPU removed ch.	HIGH BYTE RAM + RAM NOT TIED TO GRND. ICE ABLE TO TALK TO MEMORY - PROBLEMS WITH WEIRD CURRENT + NOISE ON V. + GROUND JUST NOT PRESENT! NO EXPLANATION 82PC08'S REPLACED.
VERY FIRST APPLICATION OF POWER TO DETECTOR BOARD.	CPU, MEM, + DET I/F CARDS EQUAL ≈ 500mA ON +5V + +5V RTN LINES. 8255 I/F DEVICE ON DET I/F CARD IS UN-RESPONSIVE TO EMULATOR. NO "RESET" SIGNAL APPEARS TO BE
HY-4	SUPPLIED TO THE DEVICE — PIN 69 ON CARD EDGE IS OPEN. RESET IS WIRED TO THE CHIP ITSELF. HY-4 PINS 2 + 3 — SEEM TO HAVE ONE SENSE HY-5 " " : SEEM TO HAVE OPPOSIT SENSE
	HY-5 -3 ~~MAJOR FRAME~~ — SHOULD BE HY-4-3 HY-5 -4 MAJOR FRAME ~~40H~~ IS COOL → EGS 8 HAS LEADS REVERSED HY-5 -2 MINOR FRAME ~~MINOR FRAME~~ NOT HOME. HY-3 -2 ~~400KHZ~~ ~~400KHZ~~ SEEMS BACKWARDS HY-3 -
PPS I/F CARD	DATA BIT 3 IS HELD LOW — U6 -8282 BAD, REPLACED. SECOND — U7 + U8 INPUTS + OUTPUTS WIRED BACKWARDS

DATE/COMPONENT/EVENT	DESCRIPTION
12 SEPT 85 FULL CEP.	NO MISWIRED SIGNALS IN C.E.P.; TEST CABLE
16 SEPT 85 PROCESSOR PPS BOARD	SERIAL DATA NOT CLOCKING OUT ON S9 BUT FOR DATA BITS 8+9. FOUND DRAWING ERROR SPECIFYING PINS 5+6 OR U13 AND 11,12,13,14,3+4 OF U14 AS BEING GROUNDED WHEN IN FACT THOSE WERE LIVE DATA LINES → CORRECTED WIRING OF U13 + U14 WITH SOLDER JUMPERS JOINING DATA BUSS ON U10 + U11. S9 DATA IS FUNCTIONAL.
17 SEPT 85 PROCESSOR PPS BOARD — FINAL CEP CONNECTORS J3 + J4	CEP HOUSING NOW TESTED (SANS BOARDS) FOR POWER SUPPLY + SIGNAL INTEGRITY ON THE ACTUAL SOUNDING ROCKET BUS.
" " "	ANALOGUE MONITOR SIGNALS FOR (PCM SLOTS) A41 - A50 NOW VERIFIED USING 0-5V P-P TRIANGLE WAVE. AN EXTRA SIGNAL, A54, WAS VERIFIED (P101 PIN 44), PER BILL GIBSON'S REQUEST. 100 khz, EGS8, MAS. FRAME, MINOR FRAME ON J4 + EGS9 + EGS10 ON J3 FROM THE ROCKET BUS.

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DATE/COMPONENT/EVENT	DESCRIPTION
13 OCT 85 FIMS ANALYSER/DETECTOR	ION CALIBRATION CONFIRMED FOR FIMS ~~CEP~~ CEM DETECTOR. H_2 IS SEEN IN BOTH CHANNELS.
30 DEC 85 / CEP/FUNCTIONAL	Error found + corrected in CEP flight code. MD80C86 failed + replaced. Instrument installed in Ion lab. Mass PPS failed. UA4 on I10 dead. On detector analogue board, U9 + U10 changed to 680Ω from 100Ω of the preliminary cal showed very low sensitivity. Gain resistors in detector changed back to 100Ω.
31 Dec. 85, Detector Bias Measurement.	Actual preamp output voltage = −3167V. before adjustments Float Volts = 800.3. before adjustments. Amperex B413BL/01 Channeltrons in Ions, not connected for above measurements.
	Inner channeltron is "IN 1" to digital board Outer channeltron is "IN 2" to digital board.
	Decision made to adjust preamp to −3000V and adjust divider ratio to get 815V float.
	Voltage divider of 50MΩ ± 0.5% in series with a 30MΩ ± 1% and a 50MΩ ± 1% in parallel to give a measured reference voltage of −815.0V for −2990 V in. CEM biased at this potential. CEM NOT CONNECTED FOR THIS MEASUREMENT.
	The following absolute voltage measurements were made directly on output of PPS'S.
	Strip chart outputs of monitor signals on PPS's − all verified within ± 6 V of absolute output voltage.

	(E Command)	E+	E−	M+	M−	(M Command)	(ERROR) M+	M−
+1.2%	(85.01)	86.2	86.4	99.1	98.2	(98.69)	+0.49	0.9%
+4.6%	(175.7)	184.3	185.0	183.7	135.8	(186.5)	−1.5%	0.4%
				95.2	94.4	(94.8)	+0.4%	0.4%
				187.4	182.1	(182.9)	+2.5%	0.4%

DATE/COMPONENT/EVENT	DESCRIPTION
31 DEC 85 FIMS INSTRUMENT. PRIOR TO VERIFICATION TESTS	.32 - .36 AMPS DUAL STATE CURRENTS TO CEP DURING FUNCTIONAL [SC1] .165 - .18A FOR BOTH PPS'S DURING FUNCTIONAL
2 Jan. 86 Calibration for M28, M30 @ 1020 + 2115 ev.	CONFIRMED NITROGEN @ 1.023 eV + 2133 eV CONFIRMED OXYGEN @ " " INSTRUMENT ACHIEVED TOTAL PRESSURE OF 2.9×10^{-7}T. Energy PPS still overloading at low end. Still has warmup problem. DEFLECTION VOLTAGES APPEARED TO DROP OUT
2 JAN 86 FIMS ENERGY PPS VERIFICATION EFFORT - FLIGHT EPROMS.	INSPECTION OF EPPS PROM CARD REVEALED SEVERAL FOIL PADS NOT SOLDERED TO EPROM PINS, HIGH PROBABILITY THAT SIGNALS ARE INTERMITTENT, RESULTING IN APPARENT DROP OUT OF PPS VALUES.
" "	12 PADS ARE EFFECTED. EPPS WILL BE RE TESTED AFTER PINS HAVE BEEN SOLDERED
3 JAN 86 FIMS INSTRUMENT PRIOR TO SHIPMENT.	ALL PPS BOARDS REMOVED. LOOSE CAPACITORS RTV'd IN PLACE. ALL BOARDS COATED + VACUUM BAKED CEP BOARDS HAD ALL COMPONENTS SOLDERED + WERE COATED.
" "	PRE SHIPMENT FUNCTIONAL .5 AMPS ON CEP PWR UP. CEP FUNCTIONAL (CURRENT IS DRAWN WITH INTERFACE TO SC-1).
	PPS CURRENT ~.165 AMPS CHART RECORD SHOWS +EPPS + -EPPS MONITORS IN SOME ERRONEOUS STATE BUT THEY RECOVER UPON RECIEPT OF FIRST COMMAND.
" "	Ran new E PPS test with corrected proms: absolutely no change! - Modified CEP turn on time constant to 0.4 seconds.
4 JAN 86 SCOPE FIMS INSTRUMENT FINAL TEST PRIOR TO SHIPMENT.	SYSTEM PUMPED DOWN OVERNIGHT TO 10^{-6} TORR CALIBRATION BEAM OF 1KEV DETECTED. PROPER PPS STEP + PROPER CHANNEL. BEAM INCREASED TO 2KEV. SYSTEM RESPONDED CORRECTLY. SYSTEM POWERED DOWN. PACKED FOR SHIPMENT

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DATE/COMPONENT/EVENT	DESCRIPTION
10 JAN 86 ANDOYA TEST RANGE PRE-LAUNCH TEST. WITH GSE	STIM INPUT TEST USING HP FUNCTION GENERATOR. MONITOR PCM DECOM. 1VOLT PEAK INPUT. FREQUENCY ADJUSTED TO FILL COUNTER. PCM COUNT MATCHED GEN. FREQ.
11 JAN 86 ANDOYA TEST RANGE PRE-LAUNCH END TO END TM CHECK.	LAUNCH SEQUENCE TEST COMPLETED. RECORDED DATA LOOKS GOOD ON PLAYBACK TEST OPERATED FOR EQUIVILANT TIME OF FLIGHT, 800SEC

APPENDIX B

Software Listing

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SERIES-III 8086/8087/8088 MACRO ASSEMBLER V1.0 ASSEMBLY OF MODULE TADLE
OBJECT MODULE PLACED IN :F5:TADLE.ODJ
INVOCATION LINE CONTROLS:  TITLE(17:00:00 23 DEC.85)

LOC  OBJ                LINE    SOURCE

                          1     ;***************************************************************
                          2     ;*                           TADLE.ASM                         *
                          3     ;***************************************************************
                          4     ;*                                                             *
                          5     ;*          PROCEDURE NAME:TADLE                               *
                          6     ;*              PROGRAMMER:W.C. GIBSON                         *
                          7     ;*           LAST REVISION:23 DEC.85                           *
                          8     ;*                  INPUTS:NONE                                *
                          9     ;*                                                             *
                         10     ;*                 OUTPUTS:LOADS JUMP ADDRESS FOR INTERRUPT TYPE CODE 2D *
                         11     ;*                                                             *
                         12     ;*                DESTROYS:NOTHING                             *
                         13     ;*                                                             *
                         14     ;*               FUNCTIONS:THE PURPOSE OF THIS PROCEDURE IS TO PASS THE *
                         15     ;*                         THE INTERRUPT JUMP ADDRESS FOR IR4 OF THE *
                         16     ;*                         SLAVE 8259 INTERRUPT CONTROLLER.    *
                         17     ;*                                                             *
                         18     ;*                                                             *
                         19     ;*                                                             *
                         20     ;***************************************************************
                         21                             NAME TADLE
                         22     ;*                                                             *
----                     23     DATA                    SEGMENT                     PUBLIC
                         24     ;*                                                             *
----                     25     DATA                    ENDS
                         26     ;*                                                             *
----                     27     CODE                    SEGMENT                     PUBLIC
                         28                             ASSUME CS:CODE,DS:DATA
                         29                             EXTRN  MAJOR_FRAME                  :NEAR
                         30                             PUBLIC TADLE
0000                     31     TABLE                   PROC                        NEAR
0000 1E                  32                             PUSH DS
0001 53                  33                             PUSH BX
0002 50                  34                             PUSH AX         ;PRESEVE WORKING REGISTERS
0003 B80000              35                             MOV AX,0        ;ABSOLUTE MEMORY SEG.
0006 8ED8                36                             MOV DS,AX       ;SEG. WHERE VECTOR IS LOADED
0008 BBB400              37                             MOV BX,0084H    ;OFFSET FOR TYPE CODE OF 2D
000B B80000      E       38                             MOV AX,OFFSET MAJOR_FRAME
000E 8907                39                             MOV [BX],AX     ;SEND OFFSET OF INT. ROUTINE
0010 B8----      R       40                             MOV AX,CODE     ;LOAD SEGMENT OF INT.ROUTINE
0013 894702              41                             MOV [BX+2],AX   ;LOAD SEGMENT
0016 58                  42                             POP AX          ;RESTORE
0017 5B                  43                             POP BX
0018 1F                  44                             POP DS          ;RESTORE EVERYBODE
0019 C3                  45                             RET
                         46     TADLE                   ENDP
                         47     CODE                    ENDS
                         48                             END

ASSEMBLY COMPLETE, NO ERRORS FOUND
```

```
SERIES-III 8086/8087/8088 MACRO ASSEMBLER V1.0 ASSEMBLY OF MODULE MAJOR
OBJECT MODULE PLACED IN :F6:MAJOR.OBJ
INVOCATION LINE CONTROLS:  TITLE(17:36:00 16 OCT.85)

LOC  OBJ                  LINE     SOURCE

                             1     ;*****************************************************************
                             2     ;*                     MAJOR.ASM                                  *
                             3     ;*****************************************************************
                             4     ;*                                                                *
                             5     ;*       PROCEDURE NAME:MAJOR_FRAME_INTERRUPT                     *
                             6     ;*           PROGRAMMER:W.C. GIBSON                               *
                             7     ;*        LAST REVISION:16 OCT. 1985                              *
                             8     ;*               INPUTS:NONE                                      *
                             9     ;*                                                                *
                            10     ;*              OUTPUTS:PPS COMMANDS UPDATED,1 SCIENCE WORD TO ROCKET.*
                            11     ;*                                                                *
                            12     ;*             DESTROYS:NOTHING                                   *
                            13     ;*                                                                *
                            14     ;*            FUNCTIONS:MAJOR FRAME RATE INTERRUPT SERVICE ROUTINE. *
                            15     ;*                                                                *
                            16     ;*                                                                *
                            17     ;*                                                                *
                            18     ;*****************************************************************
                            19                         NAME MAJOR
                            20     ;*                                                                *
                            21     DATA                SEGMENT                      PUBLIC
                            22                         EXTRN       PPS1STR          :NEAR
                            23                         EXTRN       PPS2STR          :NEAR
                            24                         EXTRN       DATASTR          :NEAR
                            25                         EXTRN       ENERGY_COUNTS    :NEAR
                            26                         EXTRN       MASS_COUNTS      :NEAR
                            27                         EXTRN   ENERGY_COUNTS_SPECIAL :NEAR
                            28                         EXTRN   MASS_COUNTS_SPECIAL  :NEAR
                            29                         EXTRN       MODE             :NEAR
                            30                         EXTRN       PASS_COUNT       :NEAR
                            31                         EXTRN       SCIENCE_DATA     :NEAR
                            32                         EXTRN       MINOR_FRAME      :NEAR
                            33                         EXTRN       PIC_ICW1         :NEAR
                            34     DATA                ENDS
                            35     CODE                SEGMENT                      PUBLIC
                            36                         ASSUME CS:CODE,DS:DATA
                            37                         EXTRN       GET_SCIENCE_DATA:NEAR
                            38                         EXTRN       S8259            :NEAR
                            39                         EXTRN       ENERGY_COMMANDS  :NEAR
                            40                         EXTRN       MASS_COMMANDS    :NEAR
                            41                         EXTRN   SPECIAL_MODE_ENERGY  :NEAR
                            42                         EXTRN   SPECIAL_MODE_MASS    :NEAR
                            43                         PUBLIC MAJOR_FRAME_INTERRUPT
0000                        44     MAJOR_FRAME_INTERRUPT   PROC                     NEAR
0000 57                     45                         PUSH DI          ;PRESERVE...
0001 53                     46                         PUSH BX          ;ALL WORKING...
0002 50                     47                         PUSH AX          ;REGISTERS
0003 8B3E0000       E       48     ACKNOWLEDGE_INTERRUPT:  MOV DI,WORD PTR PIC_ICW1
0007 26C7052000             49                         MOV WORD PTR ES:[DI],0020H
000C 83C702                 50                         ADD DI,2         ;POINT TO OCW1
```

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LOC  OBJ                 LINE     SOURCE

000F 26C705F900            51                          MOV WORD PTR ES:[DI],00F9H
0014 C70600000000    E     52     MAJOR_FRAME_START:   MOV WORD PTR MINOR_FRAME, 0000H
001A E80000          E     53                          CALL GET_SCIENCE_DATA
001B 833E000001      E     54     MODE_TEST:           CMP WORD PTR MODE,1
0022 7503                  55                          JNE NORMAL_MODE
0024 E98700                56                          JMP SPECIAL_MODE        ;IF MODE=1,SPECIAL MODE
0027 8306000002      E     57     NORMAL_MODE:         ADD WORD PTR ENERGY_COUNTS,2
002C 833E000058      E     58                          CMP WORD PTR ENERGY_COUNTS,88
0031 7D15                  59                          JGE ENERGY_MAX_NORMAL
0033 8B1E0000        E     60     FETCH_NORMAL_ENERGY: MOV BX,WORD PTR ENERGY_COUNTS  ?
0037 2E8B870000      E     61                          MOV AX,WORD PTR ENERGY_COMMANDS[BX]
003C F7D0                  62                          NOT AX
003E 8B3E0000        E     63                          MOV DI,WORD PTR PPS2STR
0042 268905                64                          MOV ES:[DI],AX          ;SEND ENERGY PPS CMD.
0045 EB1490                65                          JMP MASS_NORMAL         ;CONTINUE WITH MASS
0048 C70600000000    E     66     ENERGY_MAX_NORMAL:   MOV WORD PTR ENERGY_COUNTS,0
004E 2EA10000        E     67                          MOV AX,WORD PTR ENERGY_COMMANDS
0052 F7D0                  68                          NOT AX
0054 8B3E0000        E     69                          MOV DI,WORD PTR PPS2STR
0058 268905                70                          MOV ES:[DI],AX          ;SEND ENERGY 1ST CMD.
005B 8306000002      E     71     MASS_NORMAL:         ADD WORD PTR MASS_COUNTS,2
0060 813E00000602    E     72                          CMP WORD PTR MASS_COUNTS,516
0066 7D15                  73                          JGE MASS_MAX_NORMAL
0068 8B1E0000        E     74     FETCH_NORMAL_MASS:   MOV BX,WORD PTR MASS_COUNTS
006C 2E8B870000      E     75                          MOV AX,WORD PTR MASS_COMMANDS[BX]
0071 F7D0                  76                          NOT AX
0073 8B3E0000        E     77                          MOV DI,WORD PTR PPS1STR
0077 268905                78                          MOV ES:[DI],AX          ;SEND NORMAL MASS CMD.
007A E9A100                79                          JMP MAJOR_FRAME_OUT
007D C70600000000    E     80     MASS_MAX_NORMAL:     MOV WORD PTR MASS_COUNTS,0
0083 8306000001      E     81                          ADD WORD PTR PASS_COUNT,1
0088 833E00000A      E     82                          CMP WORD PTR PASS_COUNT,10
008D 720F                  83                     ?    JB NOT_SPECIAL_MODE
008F C70600000100    E     84                          MOV WORD PTR MODE,1     ;SET MODE SPECIAL
0095 C70600000000    E     85                          MOV WORD PTR PASS_COUNT,0
009B EB1190                86                          JMP SPECIAL_MODE        ;ENTER SPECIAL MODE
009E 2EA10000        E     87     NOT_SPECIAL_MODE:    MOV AX,WORD PTR MASS_COMMANDS
00A2 F7D0                  88                          NOT AX
00A4 8B3E0000        E     89                          MOV DI,WORD PTR PPS1STR
00A8 268905                90                          MOV ES:[DI],AX          ;SEND 1ST MASS CMD.
00AB EB7190                91                          JMP MAJOR_FRAME_OUT
00AE 8306000002      E     92     SPECIAL_MODE:        ADD WORD PTR ENERGY_COUNTS_SPECIAL,2
00B3 813E00000803    E     93                          CMP WORD PTR ENERGY_COUNTS_SPECIAL,775
00B9 7D15                  94                          JGE ENERGY_MAX_SPECIAL
00BB 8B1E0000        E     95                          MOV BX,WORD PTR ENERGY_COUNTS_SPECIAL
00BF 2E8B870000      E     96                          MOV AX,WORD PTR SPECIAL_MODE_ENERGY[BX]
00C4 F7D0                  97                          NOT AX
00C6 8B3E0000        E     98                          MOV DI,WORD PTR PPS2STR
00CA 268905                99                          MOV ES:[DI],AX          ;SEND SPECIAL ENERGY
00CD EB1490               100                          JMP MASS_SPECIAL
00D0 C70600000000    E    101     ENERGY_MAX_SPECIAL:  MOV WORD PTR ENERGY_COUNTS_SPECIAL,0
00D6 2EA10000        E    102                          MOV AX,WORD PTR SPECIAL_MODE_ENERGY
00DA F7D0                 103                          NOT AX
00DC 8B3E0000        E    104                          MOV DI,WORD PTR PPS2STR
00E0 268905               105                          MOV ES:[DI],AX          ;SEND MAX SPECIAL ENR.
```

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LOC  OBJ                LINE    SOURCE

00E3 8306000002     E    106    MASS_SPECIAL:          ADD WORD PTR MASS_COUNTS_SPECIAL,2
00E8 813E00001A0C   E    107                           CMP WORD PTR MASS_COUNTS_SPECIAL,3098
00EE 7B15                108                           JGE MASS_MAX_SPECIAL
00F0 8B1E0000       E    109                           MOV BX,WORD PTR MASS_COUNTS_SPECIAL
00F4 2E8B870000     E    110                           MOV AX,WORD PTR SPECIAL_MODE_MASS[DX]
00F9 F7D0                111                           NOT AX
00FB 8B3E0000       E    112                           MOV DI,WORD PTR FPS1STR
00FF 268905              113                           MOV ES:[DI],AX         ;SEND MASS SPECIAL
0102 E91A90              114                           JMP MAJOR_FRAME_OUT
0105 C70600000000   E    115    MASS_MAX_SPECIAL:      MOV WORD PTR MODE,0
010B C70600000000   E    116                           MOV WORD PTR MASS_COUNTS_SPECIAL,0
0111 2EA10000       E    117                           MOV AX,WORD PTR MASS_COMMANDS
0115 F7D0                118                           NOT AX
0117 8B3E0000       E    119                           MOV DI,WORD PTR FPS1STR
011B 268905              120                           MOV ES:[DI],AX         ;SEND MASS SPECIAL MAX
011E 58                  121    MAJOR_FRAME_OUT:       POP AX
011F 5B                  122                           POP BX
0120 5F                  123                           POP DI
0121 CF                  124                           IRET
                         125    MAJOR_FRAME_INTERRUPT  ENDP
----                     126    CODE                   ENDS
                         127                           END

ASSEMBLY COMPLETE, NO ERRORS FOUND
```

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SERIES-III 8086/8087/8088 MACRO ASSEMBLER V1.0 ASSEMBLY OF MODULE MINOR
OBJECT MODULE PLACED IN :F6:MINOR.OBJ
INVOCATION LINE CONTROLS:   TITLE(10:25:00 17 OCT.85)

LOC  OBJ                  LINE     SOURCE

                             1     ;*****************************************************************
                             2     ;*                         MINOR.ASM                             *
                             3     ;*****************************************************************
                             4     ;*                                                               *
                             5     ;*      PROCEDURE NAME:MINOR_FRAME_INTERRUPT                     *
                             6     ;*         PROGRAMMER:W.C. GIBSON                                *
                             7     ;*       LAST REVISION:17 OCT.1985                               *
                             8     ;*              INPUTS:SCIENCE DATA WORD FROM "SCIENCE_DATA"     *
                             9     ;*                                                               *
                            10     ;*             OUTPUTS:SENDS SCIENCE DATA WORD TO ROCKET         *
                            11     ;*                                                               *
                            12     ;*            DESTROYS:NOTHING                                   *
                            13     ;*                                                               *
                            14     ;*           FUNCTIONS:TO MOVE THE 2ND OF TWO SCIENCE DATA WORDS *
                            15     ;*                     FROM ITS STORAGE LOCATION AT "SCIENCE_DATA";*
                            16     ;*                     TO THE ROCKET INTERFACE SHIFT REGISTER.   *
                            17     ;*                                                               *
                            18     ;*                                                               *
                            19     ;*                                                               *
                            20     ;*****************************************************************
                            21                         NAME MINOR
                            22     ;*                                                               *
----                        23     DATA                SEGMENT                      PUBLIC
                            24                         EXTRN         DATASTR        :NEAR
                            25                         EXTRN         SCIENCE_DATA   :NEAR
                            26                         EXTRN         MINOR_FRAME    :NEAR
                            27                         EXTRN         PPI_PORTA      :NEAR
                            28                         EXTRN         PIC_ICW1       :NEAR
----                        29     DATA                ENDS
----                        30     CODE                SEGMENT                      PUBLIC
                            31                         ASSUME CS:CODE,DS:DATA
                            32                         EXTRN         GET_SCIENCE_DATA:NEAR
                            33                         PUBLIC MINOR_FRAME_INTERRUPT
0000                        34     MINOR_FRAME_INTERRUPT   PROC                     NEAR
0000 57                     35                         PUSH DI       ;PRESERVE ...
0001 53                     36                         PUSH BX       ;ALL...
0002 50                     37                         PUSH AX       ;WORKING REGISTERS
0003 8B3E0000        E      38     MINOR_FRAME_START:  MOV DI,WORD PTR PIC_ICW1
0007 B82000                 39                         MOV AX,0020H     ;NON_SPECIFIC EOI
000A 268905                 40                         MOV ES:[DI],AX   ;SEND EOI COMMAND
000D 8306000001      E      41                         ADD WORD PTR MINOR_FRAME,1
0012 833E000003      E      42                         CMP WORD PTR MINOR_FRAME,3
0017 7503                   43                         JNE MINOR_FRAME_1
0019 E80000          E      44                         CALL GET_SCIENCE_DATA
001C 833E000002      E      45     MINOR_FRAME_1:      CMP WORD PTR MINOR_FRAME,2      ;TEST FOR MINOR FRAME 1
0021 750A                   46                         JNE MINOR_FRAME_OUT
0023 8B3E0000        E      47     FETCH_NEXT_SCIENCE: MOV DI,WORD PTR DATASTR
0027 A10200          E      48     FETCH_SCIENCE_WORD: MOV AX,WORD PTR SCIENCE_DATA+2
002A 268905                 49                         MOV ES:[DI],AX   ;SEND TO ROCKET
002D 58                     50     MINOR_FRAME_OUT:    POP AX           ;RESTORE...
```

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LOC  OBJ                LINE     SOURCE

002E 5B                   51                           POP DX          ;ALL...
002F 5F                   52                           POP DI          ;WORKING REGISTERS
0030 CF                   53                           IRET            ;END
                          54     MINOR_FRAME_INTERRUPT ENDP
                          55     CODE                  ENDS
                          56                           END

ASSEMBLY COMPLETE, NO ERRORS FOUND
```

```
SERIES-III 8086/8087/8088 MACRO ASSEMBLER V1.0 ASSEMBLY OF MODULE DATAN
OBJECT MODULE PLACED IN :F6:DATA.OBJ
INVOCATION LINE CONTROLS:  TITLE(09:20:00 17 OCT.85)

LOC  OBJ                  LINE    SOURCE

                             1    ;*************************************************************
                             2    ;*                          DATA.ASM                          *
                             3    ;*************************************************************
                             4    ;*                                                           *
                             5    ;*        PROCEDURE NAME:GET_SCIENCE_DATA                    *
                             6    ;*              PROGRAMMER:W.C. GIBSON                       *
                             7    ;*          LAST REVISION:17 OCTOBER, 1985                   *
                             8    ;*                 INPUTS:SCIENCE DATA FROM FIMS DETECTORS   *
                             9    ;*                                                           *
                            10    ;*                OUTPUTS:MOVES DETECTOR DATA TO "SCIENCE_DATA" MEMORY *
                            11    ;*                                                           *
                            12    ;*              DESTROYS:PREVIOUS CONTENTS OF "SCIENCE_DATA" *
                            13    ;*                                                           *
                            14    ;*             FUNCTIONS:TO ACQUIRE SCIENCE DATA FROM THE FIMS *
                            15    ;*                       CHANNELTRON DETECTORS THROUGH THE CEP'S 8255 *
                            16    ;*                       PPI AND TO STORE THE 2 DATA WORD AT A MEMORY *
                            17    ;*                       LOCATION LABELED "SCIENCE_DATA".    *
                            18    ;*                                                           *
                            19    ;*                       WITHIN THE FIMS CEP HARDWARE,THE FOLLOWING *
                            20    ;*                       ARE GIVENS:                         *
                            21    ;*                       1)THE A0 & A1 CONTROL LINES ARE INVERTED *
                            22    ;*                         BEFORE REACHING THE FIMS DETECTOR *
                            23    ;*                       2)PORT C,BIT 1 IS ASSIGNED TO A0    *
                            24    ;*                       3)PORT C,BIT 4 IS ASSIGNED TO A1    *
                            25    ;*                       4)THE CEP EXPECTS TO SEE AN AMPTEK D40J *
                            26    ;*                         COUNTER/LATCH IN THE DETECTOR     *
                            27    ;*                                                           *
                            28    ;*                                                           *
                            29    ;*************************************************************
                            30                            NAME DATAN
                            31
                            32    DATA                    SEGMENT                    PUBLIC
                            33                            EXTRN      PPI_PORTA       :NEAR
                            34                            EXTRN      PPI_PORTB       :NEAR
                            35                            EXTRN      PPI_PORTC       :NEAR
                            36                            EXTRN      SCIENCE_DATA    :NEAR
                            37                            EXTRN      PPI_CONTROL     :NEAR
                            38                            EXTRN      DATASTR         :NEAR
----                        39    DATA                    ENDS
----                        40    CODE                    SEGMENT                    PUBLIC
                            41                            ASSUME CS:CODE,DS:DATA
                            42                            PUBLIC GET_SCIENCE_DATA
0000                        43    GET_SCIENCE_DATA        PROC                       NEAR
0000 57                     44                            PUSH DI    ;PRESERVE...
0001 56                     45                            PUSH SI    ;ALL...
0002 53                     46                            PUSH BX    ;WORKING...
0003 50                     47                            PUSH AX    ;REGISTERS
0004 8B3E0000      E        48    SCIENCE_DATA_START:     MOV DI,WORD PTR PPI_CONTROL
0008 8B360000      E        49                            MOV SI,WORD PTR PPI_PORTB
000C B80300                 50                            MOV AX,0003H               ;SET A0
```

```
LOC  OBJ               LINE    SOURCE

000F 268905              51    CLEAR_A0_A1:          MOV ES:[DI],AX
0012 E84500              52                          CALL DELAY                       ;WAIT & MICRO.
0015 B80600              53                          MOV AX,0006H                     ;CLEAR A1
0018 268905              54    READ_FIRST_WORD:      MOV ES:[DI],AX
001B E83C00              55                          CALL DELAY                       ;WAIT AGAIN
001E E83900              56                          CALL DELAY
0021 268B04              57    FETCH_DATA_WORD:      MOV AX,WORD PTR ES:[SI]          ;FETCH DET.
0024 F7D0                58                          NOT AX
0026 8B3E0000     E      59                          MOV DI,WORD PTR DATASTR
002A 268905              60                          MOV WORD PTR ES:[DI],AX          ;SEND DATA
002D 8B3E0000     E      61                          MOV DI,WORD PTR PPI_CONTROL
0031 B80700              62                          MOV AX,0007H                     ;SET A1
0034 268905              63                          MOV ES:[DI],AX                   ;
0037 E82000              64                          CALL DELAY                       ;WAIT
003A B80200              65                          MOV AX,0002H                     ;CLR A0
003D 268905              66                          MOV ES:[DI],AX                   ;CLR A0
0040 E81700              67                          CALL DELAY
0043 E81400              68                          CALL DELAY
0046 268B04              69    FETCH_SECOND_WORD:    MOV AX,WORD PTR ES:[SI]          ;FETCH 2ND
0049 F7D0                70                          NOT AX
004B 8B3E0000     E      71                          MOV DI,WORD PTR PPI_PORTA
004F 268905              72                          MOV WORD PTR ES:[DI],AX          ;
0052 A30200       E      73                          MOV WORD PTR SCIENCE_DATA+2,AX   ;STORE 2ND WRD
0055 58                  74                          POP AX                           ;RESTORE
0056 5B                  75                          POP BX
0057 5E                  76                          POP SI                           ;ALL...
0058 5F                  77                          POP DI                           ;REGISTERS
0059 C3                  78                          RET                              ;DONE
                         79    GET_SCIENCE_DATA      ENDP
005A                     80    DELAY                 PROC                             NEAR
005A 90                  81                          NOP                              ;DELAY 3 CLK'S
005B C3                  82                          RET                              ;RETURN
                         83    DELAY                 ENDP                             ;KILLS 6 MICR.
----                     84    CODE                  ENDS
                         85                          END

ASSEMBLY COMPLETE, NO ERRORS FOUND
```

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OF POOR QUALITY

```
SERIES-III 8086/8087/8088 MACRO ASSEMBLER V1.0 ASSEMBLY OF MODULE FIMS
OBJECT MODULE PLACED IN :F6:FIMCAL.OBJ
INVOCATION LINE CONTROLS:  TITLE(CAL ONLY 31 DEC.85)

LOC  OBJ           SOURCE

                   ;*****************************************************************
                   ;*                         FCAL.ASM                              *
                   ;*****************************************************************
                   ;*                                                               *
                   ;*       PROCEDURE NAME:FIMS_MAIN                                *
                   ;*           PROGRAMMER:W.C. GIBSON                              *
                   ;*        LAST REVISION:30 DEC.     1985                         *
                   ;*               INPUTS:NONE                                     *
                   ;*                                                               *
                   ;*              OUTPUTS:CONFIGURES 8259,8255 AND PPS INTERFACES  *
                   ;*                                                               *
                   ;*             DESTROYS:ALL REGISTERS                            *
                   ;*                                                               *
                   ;*            FUNCTIONS:THIS ROUTINE IS THE MAIN PROGRAM ELEMENT OF *
                   ;*                      THE FIMS-C INSTRUMENT CENTRAL ELECTRONICS *
                   ;*                      PROCESSOR.THIS ROUTINE FIRST INITIALIZES *
                   ;*                      THE SEGMENT REGISTERS THEN THE VARIOUS   *
                   ;*                      HARDWARE ELEMENTS.HAVING INITIALIZED ALL OFF *
                   ;*                      THE DEVICES REQUIRING INITIALIZATION.THIS *
                   ;*                      ROUTINE HALTS AND WAITS FOR A MAJOR OR MINOR *
                   ;*                      FRAME INTERRUPT.                         *
                   ;*                                                               *
                   ;*                                                               *
                   ;*                                                               *
                   ;*****************************************************************
                                 NAME FIMS
                   ;*                                                               *
----               DATA          SEGMENT              PUBLIC
0000 0002          PERIPHERALS   DW                   0200H
0002 00F0          PROM_SEGMENT  DW                   0F000H
0004 00C0          PROM_OFFSET   DW                   0C000H
0006 0000          RAM_SEGMENT   DW                   0000H
0008 0000          RAM_OFFSET    DW                   0000H
000A 0000          STACK_SEGMENT DW                   0000H
000C 000F          STACK_POINTER DW                   0F00H
000E 3000          PPI_PORTA     DW                   0030H
0010 3400          PPI_PORTB     DW                   0034H
0012 3200          PPI_PORTC     DW                   0032H
0014 3600          PPI_CONTROL   DW                   0036H
0016 4000          PIC_ICW1      DW                   0040H
0018 0000          PPS1STR       DW                   0000H
001A 1000          PPS2STR       DW                   0010H
001C 2000          DATASTR       DW                   0020H
                                 PUBLIC           PERIPHERALS
                                 PUBLIC           PROM_SEGMENT
                                 PUBLIC           PROM_OFFSET
                                 PUBLIC           RAM_SEGMENT
                                 PUBLIC           RAM_OFFSET
                                 PUBLIC           STACK_SEGMENT
                                 PUBLIC           STACK_POINTER
```

```
LOC  OBJ          SOURCE

                                          PUBLIC      PPI_PORTA
                                          PUBLIC      PPI_PORTB
                                          PUBLIC      PPI_PORTC
                                          PUBLIC      PPI_CONTROL
                                          PUBLIC      PIC_ICW1
                                          PUBLIC      PPS1STR
                                          PUBLIC      PPS2STR
                                          PUBLIC      DATASTR
001E 0000         MINOR_FRAME             DW          0000
0020 0000         ENERGY_COUNTS           DW          0000
0022 0000         MASS_COUNTS             DW          0000
0024 0000         PASS_COUNT              DW          0000
                                          PUBLIC      MINOR_FRAME
                                          PUBLIC      ENERGY_COUNTS
                                          PUBLIC      MASS_COUNTS
                                          PUBLIC      PASS_COUNT
0026 (32          SCIENCE_DATA            DW          32 DUP(0)
      0000
      )
                                          PUBLIC      SCIENCE_DATA
0066 0000         ENERGY_COUNTS_SPECIAL   DW          0000
0068 0000         MASS_COUNTS_SPECIAL     DW          0000
006A 0000         MODE                    DW          0000
006C 0000         SPARE4                  DW          0000
                                          PUBLIC      ENERGY_COUNTS_SPECIAL
                                          PUBLIC      MASS_COUNTS_SPECIAL
                                          PUBLIC      MODE
                                          PUBLIC      SPARE4
----              DATA                    ENDS
----              CODE                    SEGMENT                 PUBLIC
                                          ASSUME CS:CODE,DS:DATA
0000 7B02         ENERGY_COMMANDS         DW     635,708,635,708
0002 C402
0004 7B02
0006 C402
0008 8A02         MASS_COMMANDS           DW     650,714,646,712
000A CA02
000C 8602
000E C802
                                          PUBLIC      ENERGY_COMMANDS
                                          PUBLIC      MASS_COMMANDS
                                          PUBLIC      FIMS_MAIN
                                          EXTRN       S8255:NEAR
                                          EXTRN       S8259:NEAR
                                          EXTRN       JTABLE:NEAR
0010 FA           FIMS_MAIN:              CLI             ;DISABLE INTERRUPTS FOR NOW
0011 B8----   R                           MOV AX,CODE     ;PREPARE DS
0014 8ED8                                 MOV DS,AX       ;INITIALIZE DS TO DATA SEG.
0016 BE0020                               MOV SI,2000H    ;OFFSET OF STORED DATA SEG.
0019 BF0008                               MOV DI,0800H    ;DESTINATION OF DATA SEG.
001C B90004                               MOV CX,0400H    ;BYTE COUNT OF DATA SEG.
001F B80000                               MOV AX,0        ;LOAD RAM SEGMENT
0022 8EC0                                 MOV ES,AX       ;LOAD ES WITH SEG. OF DESTIN.
0024 F3           REP                     MOVSB           ;STORE DATA SEMENT IN RAM
0025 A4
```

Sequencing

E	m	Energy Mass
27B	28A	1KV 30
2C4	2CA	1KV 30
27B	284	2KV 28
2C4	2C8	2KV 28

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```
LOC  OBJ                LINE    SOURCE

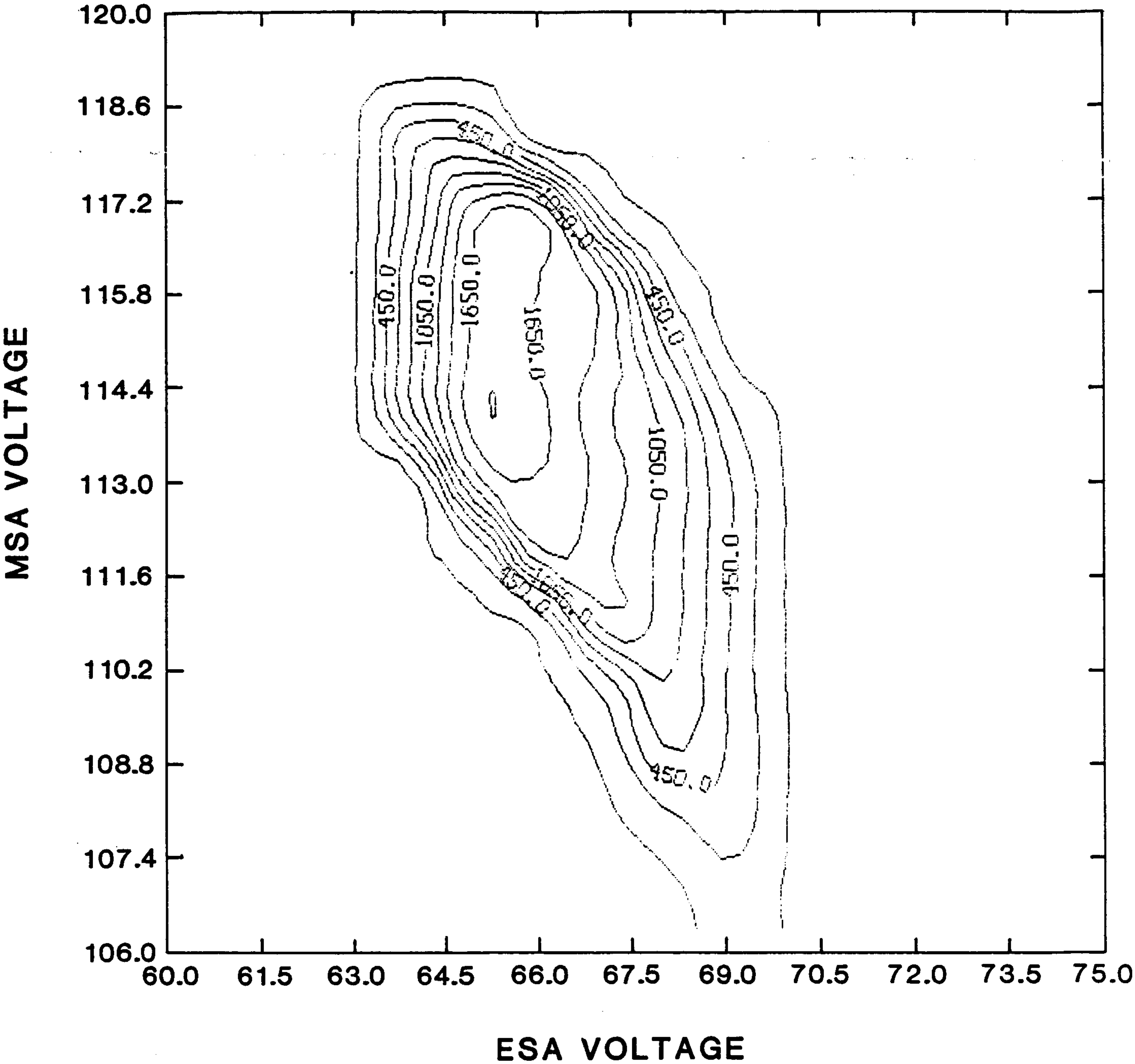
0026 B8----        R      97                           MOV AX,DATA
0029 8ED8                 98                           MOV DS,AX       ;RE_INIT.DS
002B A10000        R      99                           MOV AX,WORD PTR PERIPHERALS
002E 8EC0                100                           MOV ES,AX       ;INIT.ES TO SEG. OF PERIPH'S
0030 A10A00        R     101                           MOV AX,WORD PTR STACK_SEGMENT
0033 8ED0                102                           MOV SS,AX       ;INIT.SS TO "STACK_SEGMENT"
0035 A10C00        R     103                           MOV AX,WORD PTR STACK_POINTER
0038 8BE0                104                           MOV SP,AX       ;INITIALIZE SP
003A E80000        E     105    INITIALIZE_8259:       CALL S8259      ;CONFIGURE 8259 FOR NORMAL OP.
003D E80000        E     106    INITIALIZE_8255:       CALL S8255      ;CONFIGURE 8255
0040 E80000        E     107                           CALL JTABLE     ;LOAD INTERRUPT LINKAGE ADD'S
0043 8B3E1A00      R     108    INITIALIZE_PPS:        MOV DI,WORD PTR PPS2STR
0047 2EA10000      R     109                           MOV AX,WORD PTR ENERGY_COMMANDS
004B F7D0                110                           NOT AX          ;INVERT AX FOR INTERFACE
004D 268905              111                           MOV ES:[DI],AX  ;SEND STARTING ENERGY PPS CMD
0050 8B3E1800      R     112                           MOV DI,WORD PTR PPS1STR
0054 2EA10800      R     113                           MOV AX,WORD PTR MASS_COMMANDS
0058 F7D0                114                           NOT AX          ;INVERT PPS COMMANDS
005A 268905              115                           MOV ES:[DI],AX  ;SEND INIT. MASS PPS COMMAND
005D 8B3E1C00      R     116                           MOV DI,WORD PTR DATASTR
0061 B80000              117                           MOV AX,0        ;LOAD 1ST SCIENCE WORD
0064 268905              118                           MOV ES:[DI],AX  ;SEND 0 TO ROCKET 1ST
0067 FB                  119    TURN_ON_INTERRUPTS:    STI             ;TURN ON INTERRUPT SYSTEM
0068 F4                  120    PAUSE_LOCATION:        HLT             ;STOP AND WAIT FOR INTERRUPTS
0069 EBFC                121                           JMP TURN_ON_INTERRUPTS
----                     122    CODE                   ENDS
                         123                           END

ASSEMBLY COMPLETE, NO ERRORS FOUND
```

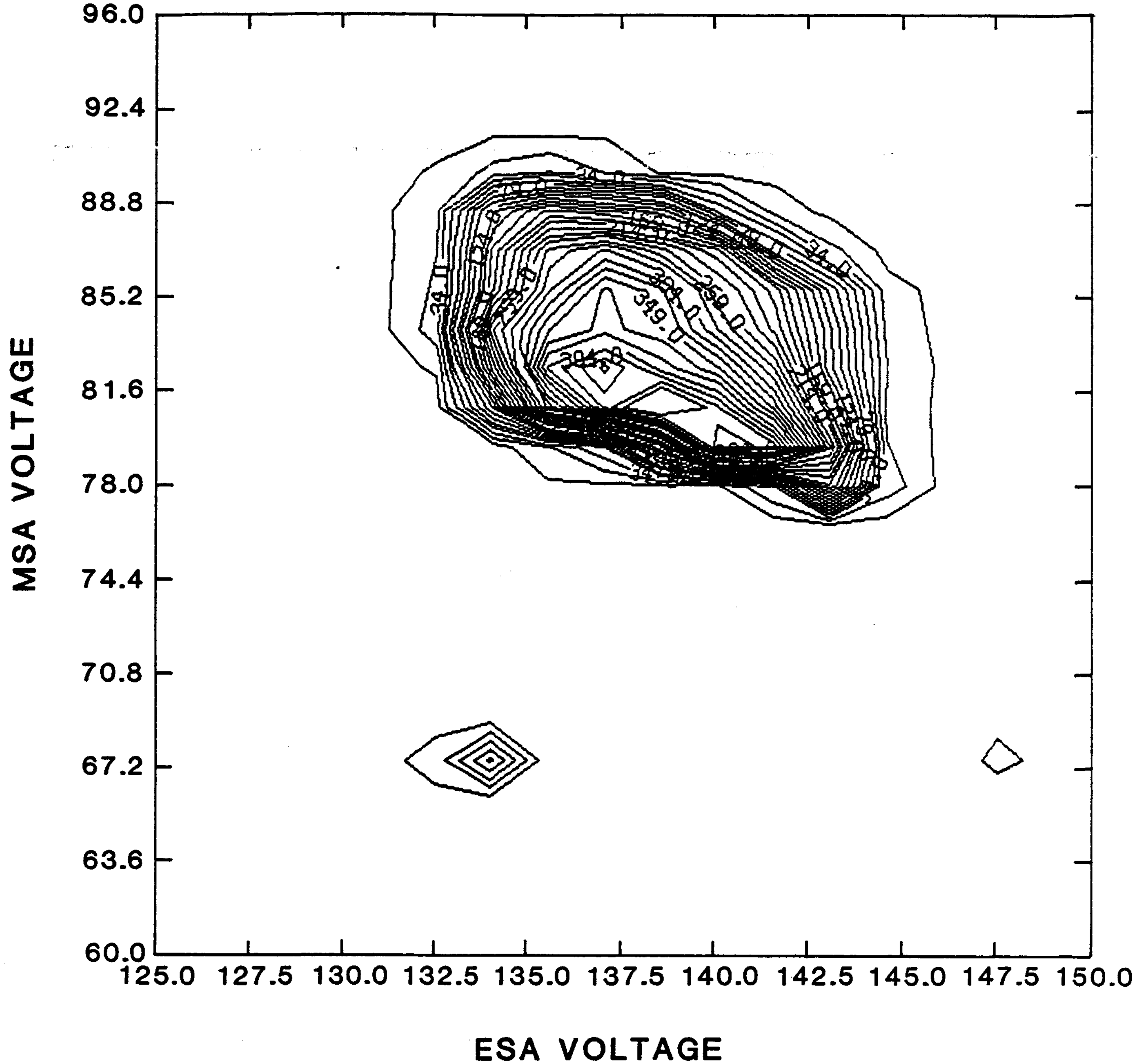
APPENDIX C

Lab Data Plots

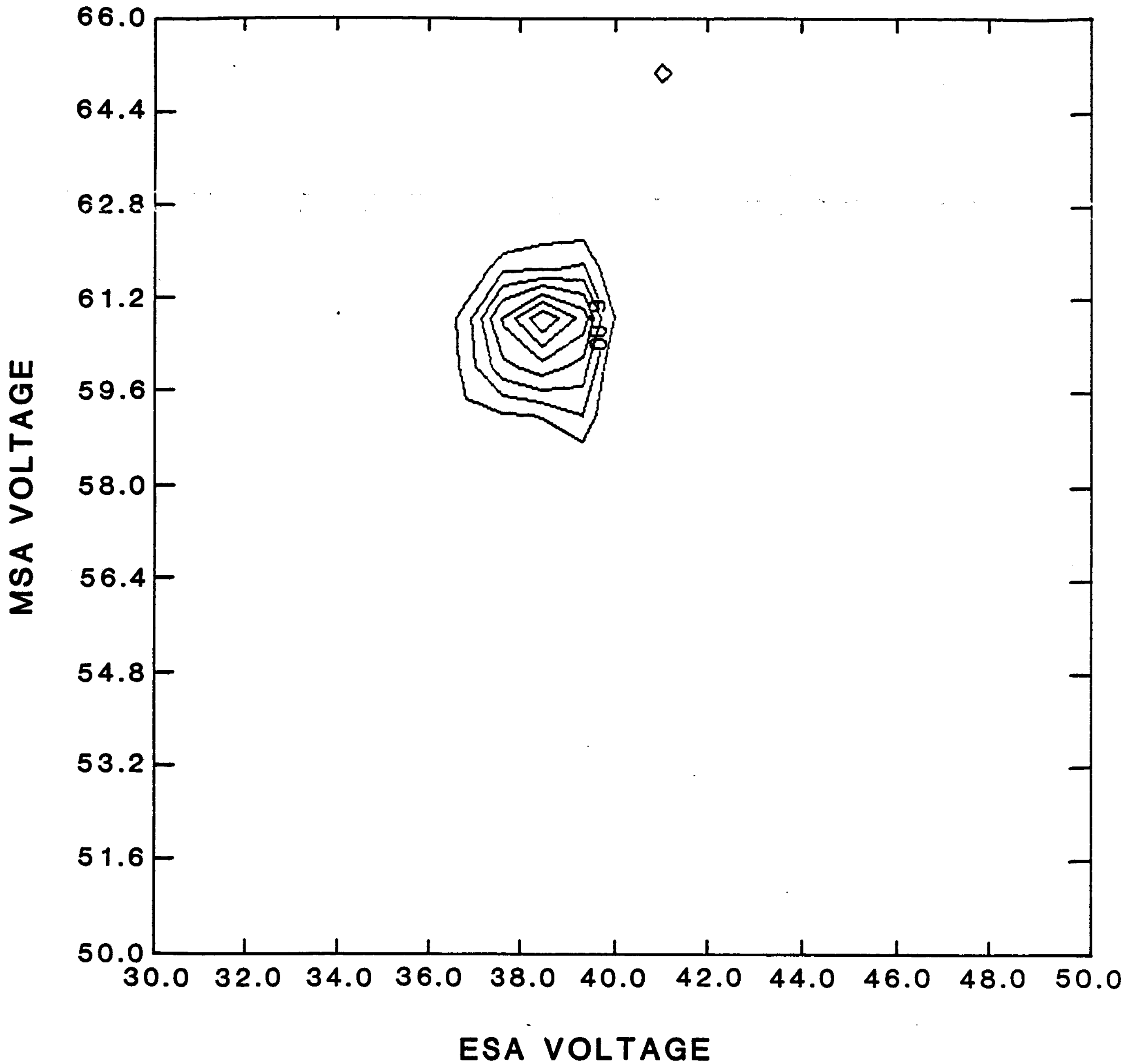
INNER CHANNEL H_2 1 KeV

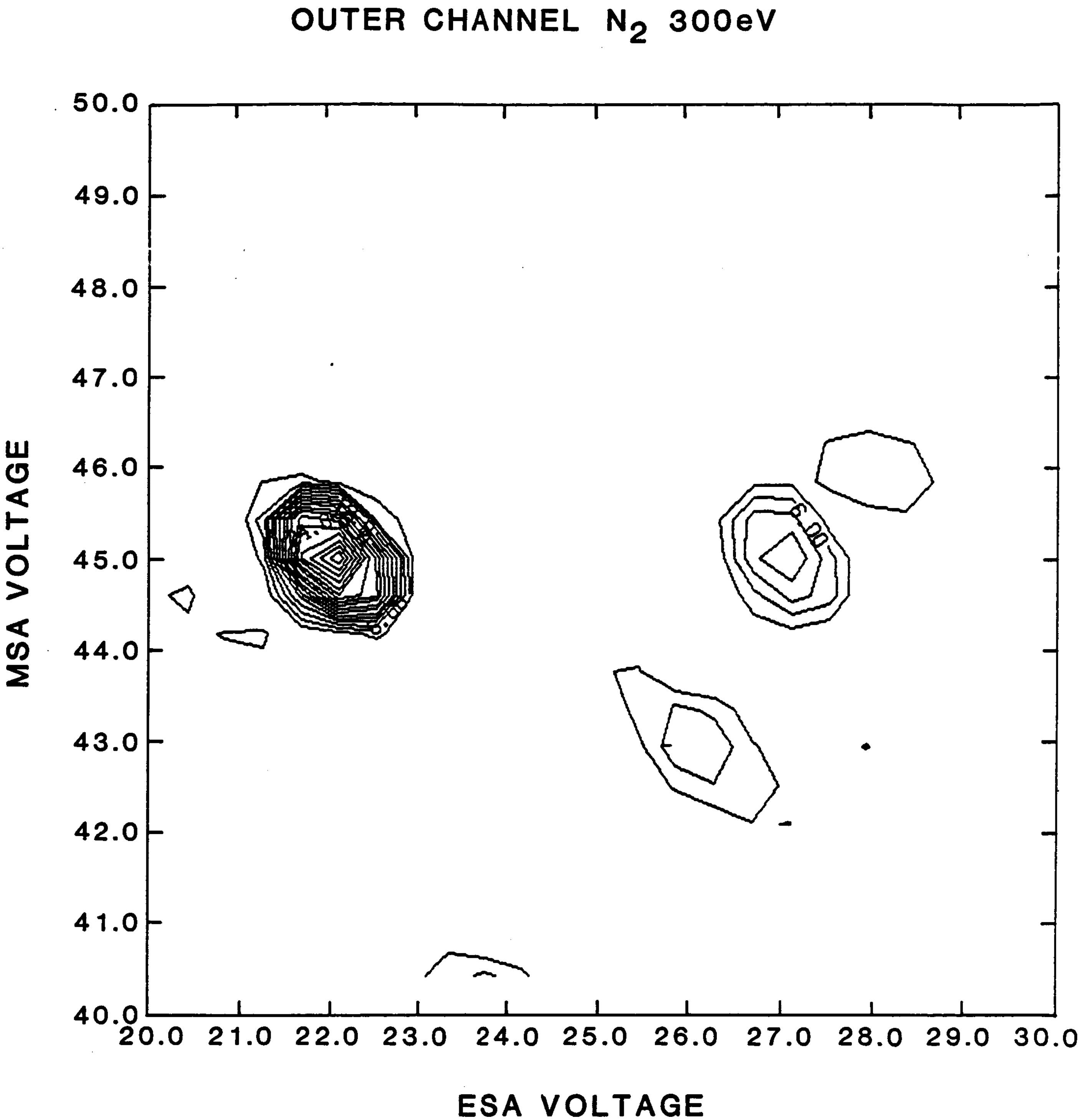


OUTER CHANNEL H_2 1 KeV

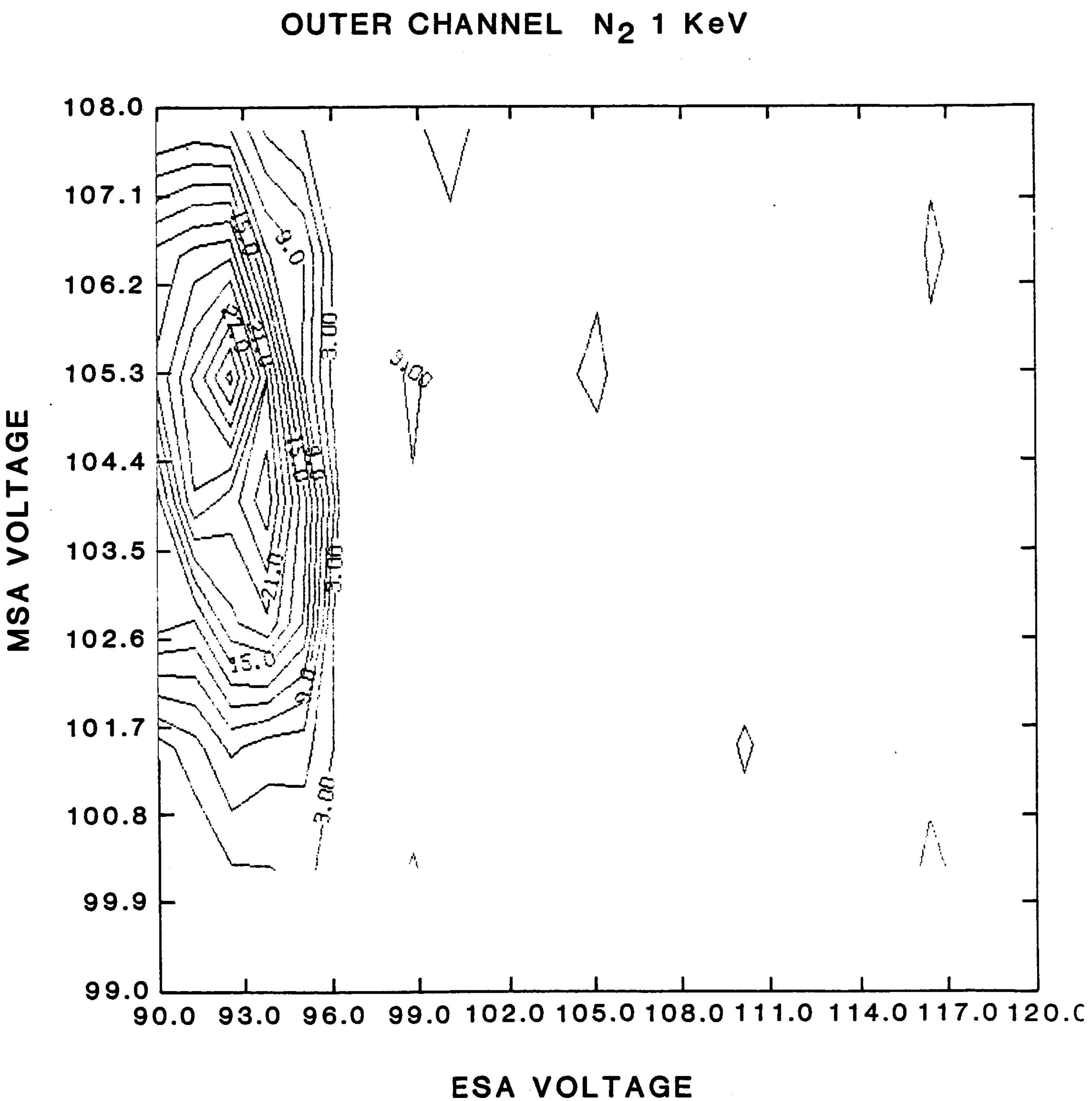


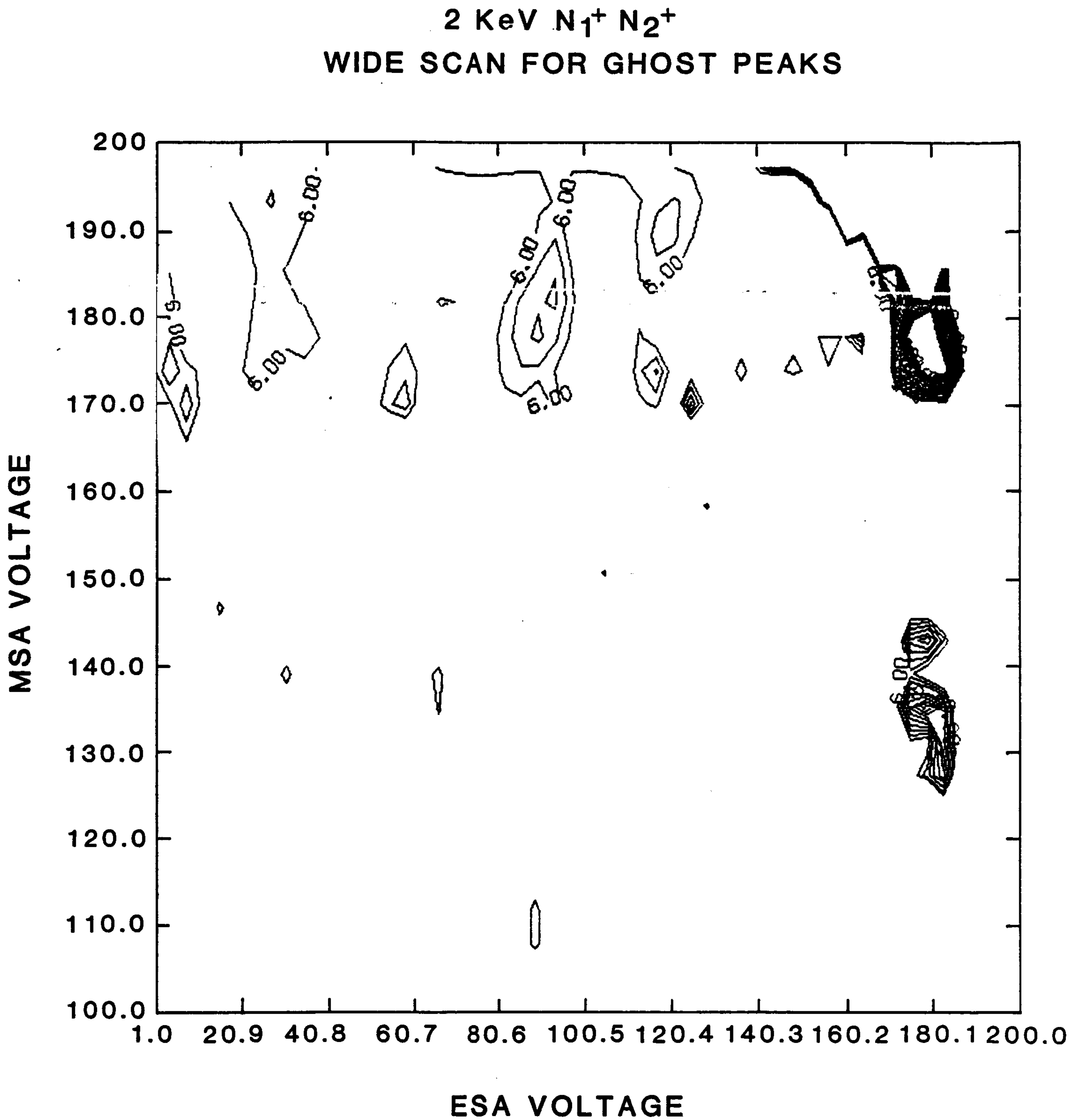
OUTER CHANNEL N_2 500eV



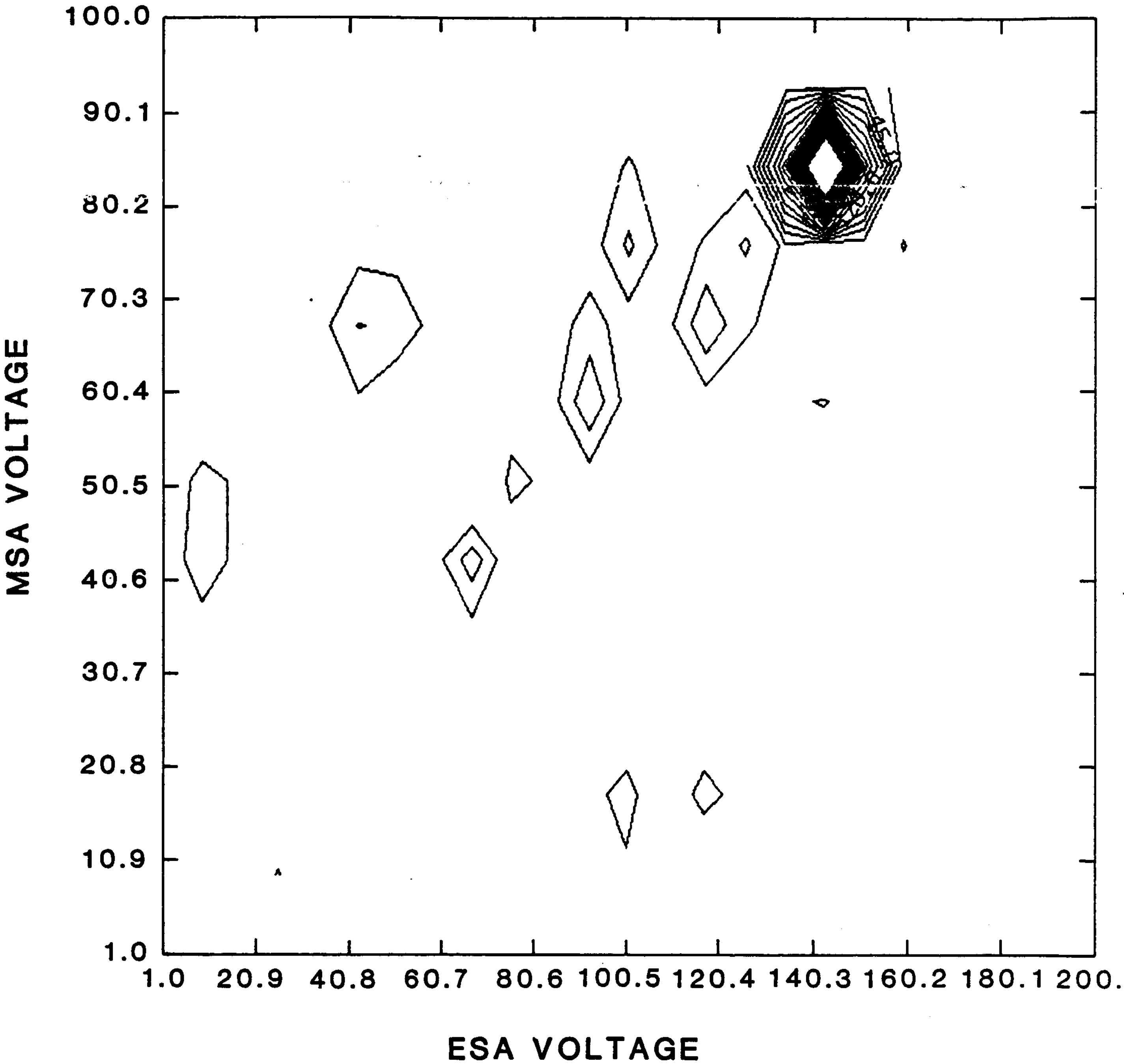


OUTER CHANNEL N_2 300eV
MSA VOLTAGE
ESA VOLTAGE
50.0
49.0
48.0
47.0
46.0
45.0
44.0
43.0
42.0
41.0
40.0
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0
30.0


OUTER CHANNEL N_2 1 KeV
MSA VOLTAGE
108.0
107.1
106.2
105.3
104.4
103.5
102.6
101.7
100.8
99.9
99.0
90.0 93.0 96.0 99.0 102.0 105.0 108.0 111.0 114.0 117.0 120.0
ESA VOLTAGE
3.00
9.0
15.0
21.0


2 KeV N_1^+ N_2^+
WIDE SCAN FOR GHOST PEAKS
MSA VOLTAGE
ESA VOLTAGE
200
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
1.0
20.9
40.8
60.7
80.6
100.5
120.4
140.3
160.2
180.1
200.0
6.00

INNER CHANNEL H_2 2 KeV



APPENDIX D

Listing of Power Supply Settings

.0149

FIMS COMMAND TABLES

ENERGY	ENERGY PPS	MASS PPS	PROM 1	PROM2	SPECIES
1.000	.150	25.063	0000	0203	30
1.200	.150	25.077	0000	0203	30
1.439	.150	25.092	0000	0203	30
1.727	.150	25.111	0000	0203	30
2.073	.173	25.134	000F	0203	30
2.487	.207	25.161	0021	0203	30
2.985	.249	25.193	0033	0203	30
3.582	.298	25.232	0046	0204	30
4.298	.358	25.279	0058	0204	30
5.158	.430	25.336	006A	0204	30
6.189	.516	25.403	007D	0204	30
7.427	.619	25.484	008F	0205	30
8.913	.743	25.582	00A1	0205	30
10.695	.891	25.679	00B4	0205	30
12.834	1.070	25.839	00C6	0206	30
15.401	1.283	26.008	00D8	0207	30
18.481	1.540	26.210	00EB	0207	30
22.177	1.848	26.453	00FD	0208	30
26.613	2.218	26.746	010F	0209	30
31.935	2.661	27.097	0122	020B	30
38.322	3.194	27.519	0134	020C	30
45.987	3.832	28.027	0146	020E	30
55.184	4.599	28.638	0158	0210	30
66.221	5.518	29.373	016B	0213	30
79.465	6.622	30.258	017D	0216	30
95.358	7.947	31.324	018F	0219	30
114.430	9.536	32.610	01A2	021D	30
137.316	11.443	34.162	01B4	0222	30
164.779	13.732	36.035	01C6	0227	30
197.734	16.478	38.299	01D9	022E	30
237.281	19.773	41.038	01EB	0234	30
284.738	23.728	44.354	01FD	023C	30
341.685	28.474	48.374	0210	0245	30
410.022	34.169	53.251	0222	024F	30
492.027	41.002	59.175	0234	0259?	30
590.432	49.203	66.377	0247	0265	30
708.518	59.043	75.138	0259	0271?	30
850.222	70.852	85.804	026B	027F	30
1020.266	85.022)	98.796)	027E	028D	30
1224.320	102.027	114.624	0290	029C	30
1469.184	122.432	133.913	02A2	02AB	30
1763.020	146.918	157.416	02B5	02BC	30
2115.624	176.302	186.048	02C7	02CC	30
1.000	.150	23.077	0000	01FB	28
1.200	.150	23.089	0000	01FB	28
1.439	.150	23.105	0000	01FB	28
1.727	.150	23.123	0000	01FB	28
2.073	.173	23.145	000F	01FB	28
2.487	.207	23.172	0021	01FB	28
2.985	.249	23.204	0033	01FB	28
3.582	.298	23.242	0046	01FB	28
4.298	.358	23.288	0058	01FC	28
5.158	.430	23.344	006A	01FC	28
6.189	.516	23.410	007D	01FC	28
7.427	.619	23.490	008F	01FC	28
8.913	.743	23.585	00A1	01FD	28
10.695	.891	23.700	00B4	01FD	28
12.834	1.070	23.838	00C6	01FE	28
15.401	1.283	24.003	00D8	01FF	28
18.481	1.540	24.202	00EB	01FF	28
22.177	1.848	24.441	00FD	0200	28
26.613	2.218	[illegible]	010F	[illegible]	28

31 Dec 85

Fims-C

For 815V float

Fims 3 Program

Cal Proms

(94.4 - 182.1) m -

(99.1 - 183.7) m +

(95.2 - 184.4) m +

(98.2 - 185.8) m -

Cal Proms!

(86.4 - 185.0) E -

(86.2 184.3) E +

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38.322	3.194	25.487	0134	0205	28
45.987	3.832	25.986	0146	0207	28
55.184	4.599	26.586	0158	0209	28
66.221	5.518	27.308	016B	020C	28
79.465	6.622	28.178	017D	020F	28
95.358	7.947	29.226	018F	0212	28
114.430	9.536	30.490	01A2	0217	28
137.316	11.443	32.015	01B4	021C	28
164.779	13.732	33.858	01C6	0221	28
197.734	16.478	36.085	01D9	0228	28
237.281	19.773	38.781	01EB	022F	28
284.738	23.728	42.047	01FD	0237	28
341.685	28.474	46.008	0210	0240	28
410.022	34.169	50.817	0222	024A	28
492.027	41.002	56.661	0234	0255	28
590.432	49.203	63.769	0247	0261	28
708.518	59.043	72.423	0259	026E	28
850.222	70.852	82.966	026B	027B	28
1020.266	85.022	95.816	027E	028A	28
1224.320	102.027	111.483	0290	0299	28
1469.184	122.432	130.588	02A2	02A9	28
1763.020	146.918	153.884	02B5	02B9	28
2115.624	176.302	182.282	02C7	02CA	28
1.000	.150	.150	0000	0000	2
1.200	.150	.150	0000	0000	2
1.439	.150	.150	0000	0000	2
1.727	.150	.150	0000	0000	2
2.073	.150	.150	0000	0000	2
2.487	.166	.150	000B	0000	2
2.985	.199	.150	001D	0000	2
3.582	.239	.150	002F	0000	2
4.298	.287	.150	0042	0000	2
5.158	.344	.150	0054	0000	2
6.189	.413	.150	0066	0000	2
7.427	.495	.150	0079	0000	2
8.913	.594	.150	008B	0000	2
10.695	.713	.150	009D	0000	2
12.834	.856	.150	00AF	0000	2
15.401	1.027	.150	00C2	0000	2
18.481	1.232	.150	00D4	0000	2
22.177	1.478	.150	00E6	0000	2
26.613	1.774	.150	00F9	0000	2
31.935	2.129	.150	010B	0000	2
38.322	2.555	.150	011D	0000	2
45.987	3.066	.150	0130	0000	2
55.184	3.679	.150	0142	0000	2
66.221	4.415	.150	0154	0000	2
79.465	5.298	.150	0167	0000	2
95.358	6.357	.150	0179	0000	2
114.430	7.629	.150	018B	0000	2
137.316	9.154	.150	019E	0000	2
164.779	10.985	.150	01B0	0000	2
197.734	13.182	.150	01C2	0000	2
237.281	15.819	.150	01D5	0000	2
284.738	18.983	.150	01E7	0000	2
341.685	22.779	.150	01F9	0000	2
410.022	27.335	.150	020C	0000	2
492.027	32.802	.150	021E	0000	2
590.432	39.362	.150	0230	0000	2
708.518	47.235	.150	0243	0000	2
850.222	56.681	.150	0255	0000	2
1020.266	68.018	.150	0267	0000	2
1224.320	81.621	.150	027A	0000	2
1469.184	97.946	.150	028C	0000	2
1763.020	117.535	.150	029F	0000	2

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2115.624	141.042	.150	02B1	0000	2
1.000	.150	26.861	0000	020A	32
1.200	.150	26.874	0000	020A	32
1.439	.150	26.890	0000	020A	32
1.727	.150	26.910	0000	020A	32
2.073	.173	26.933	000F	020A	32
2.487	.207	26.960	0021	020A	32
2.985	.249	26.993	0033	020A	32
3.582	.298	27.033	0046	020B	32
4.298	.358	27.081	0058	020B	32
5.158	.430	27.138	006A	020B	32
6.189	.516	27.207	007D	020B	32
7.427	.619	27.289	008F	020B	32
8.913	.743	27.388	00A1	020C	32
10.695	.891	27.507	00B4	020C	32
12.834	1.070	27.650	00C6	020D	32
15.401	1.283	27.821	00D8	020D	32
18.481	1.540	28.027	00EB	020E	32
22.177	1.848	28.274	00FD	020F	32
26.613	2.218	28.571	010F	0210	32
31.935	2.661	28.928	0122	0211	32
38.322	3.194	29.357	0134	0213	32
45.987	3.832	29.873	0146	0215	32
55.184	4.599	30.494	0158	0217	32
66.221	5.518	31.241	016B	0219	32
79.465	6.622	32.140	017D	021C	32
95.358	7.947	33.223	018F	021F	32
114.430	9.536	34.529	01A2	0223	32
137.316	11.443	36.104	01B4	0228	32
164.779	13.732	38.005	01C6	022D	32
197.734	16.478	40.302	01D9	0233	32
237.281	19.773	43.079	01EB	0239	32
284.738	23.728	46.441	01FD	0241	32
341.685	28.474	50.514	0210	0249	32
410.022	34.169	55.454	0222	0253	32
492.027	41.002	61.451	0234	025D	32
590.432	49.203	68.736	0247	0268	32
708.518	59.043	77.594	0259	0274	32
850.222	70.852	88.372	026B	0282	32
1020.266	85.022	101.492	027E	028F	32
1224.320	102.027	117.466	0290	029E	32
1469.184	122.432	136.920	02A2	02AE	32
1763.020	146.918	160.611	02B5	02BE	32
2115.624	176.302	189.455	02C7	02CE	32
1.000	.150	4.156	0000	014E	16
1.200	.150	4.167	0000	014F	16
1.439	.150	4.179	0000	014F	16
1.727	.150	4.195	0000	014F	16
2.073	.173	4.213	000F	0150	16
2.487	.207	4.235	0021	0150	16
2.985	.249	4.261	0033	0151	16
3.582	.298	4.292	0046	0152	16
4.298	.358	4.330	0058	0152	16
5.158	.430	4.375	006A	0153	16
6.189	.516	4.430	007D	0155	16
7.427	.619	4.495	008F	0156	16
8.913	.743	4.573	00A1	0158	16
10.695	.891	4.668	00B4	015A	16
12.834	1.070	4.781	00C6	015C	16
15.401	1.283	4.917	00D8	015F	16
18.481	1.540	5.080	00EB	0163	16
22.177	1.848	5.277	00FD	0166	16
26.613	2.218	5.513	010F	016B	16
31.935	2.661	5.797	0122	0170	16
38.322	3.194	6.139	0134	0176	16
45.987	3.832	6.551	0146	[illegible]	16

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OF POOR QUALITY